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PHOTOGRAPHIC INTERPRETATION REPORT

COMPARISON OF LARGE LIQUID PROPELLANT ROCKET ENGINE TEST FACILITIES IN THE USSR

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FEBRUARY 1967
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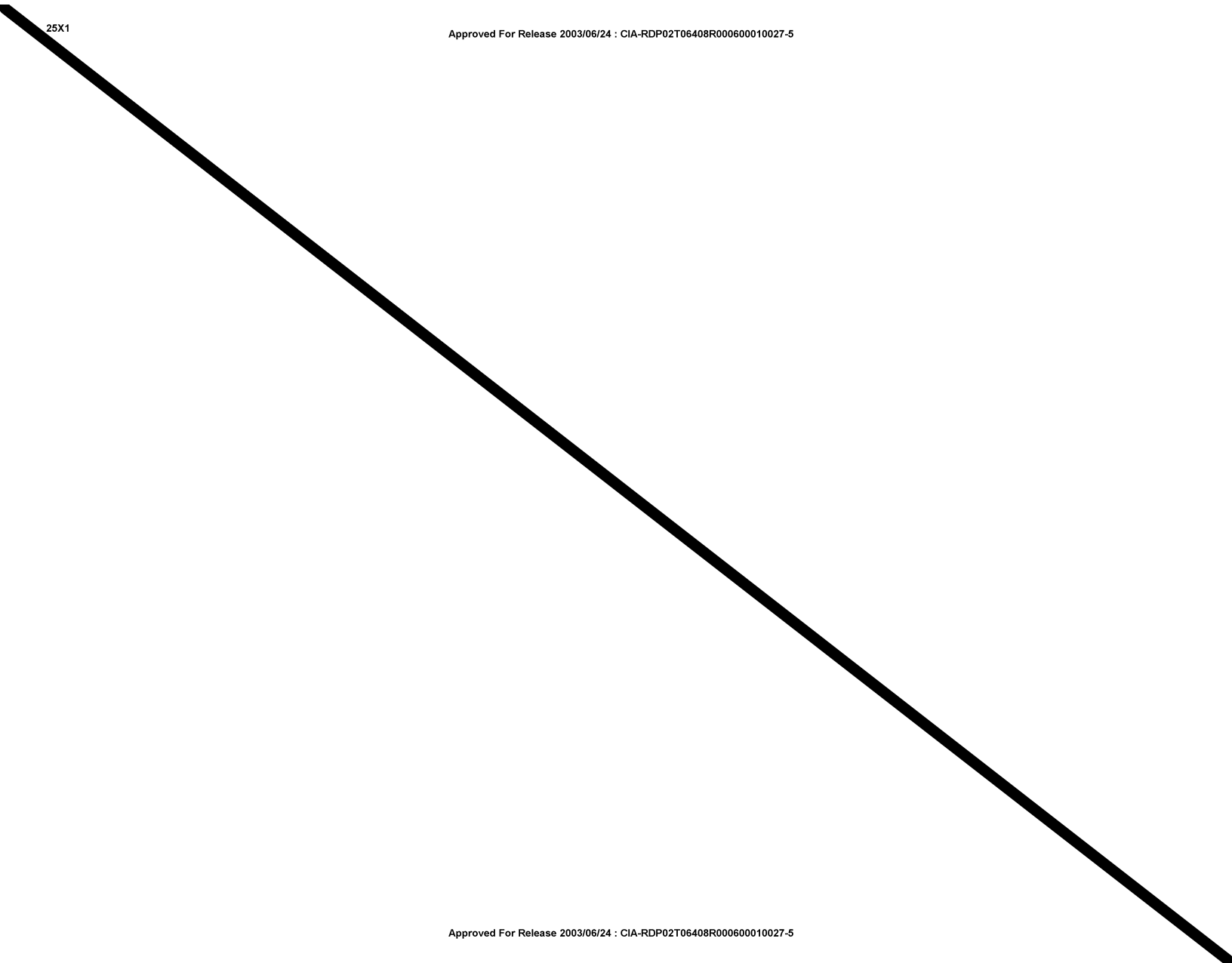

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COMPARISON OF LARGE LIQUID PROPELLANT ROCKET ENGINE TEST FACILITIES IN THE USSR

FEBRUARY 1967

NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

PREFACE

This report was prepared in response to GMAIC Requirement 31 and presents detailed comparisons and construction chronologies of large vertical test stands located at Soviet liquid propellant rocket engine test facilities. Layouts of the facilities illustrate the relationships between test stands and support structures, the siting of the test stands, and the use made of natural terrain features at the facilities. Dimensions of the test stands and support structures and the topography of the test facilities have been determined from photography using programmed orbital data and stereocompilation techniques.

All line drawings of the facilities have been drawn to the same scale to permit an easy comparison of their relative size and complexity. The perspective drawings of the test stands are also presented at approximately the same scale to aid in comparing their differences and similarities. A cross index of almost identical structures that probably have similar functions and tables showing the chronological development of the test stands are presented as an aid to the user.

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SUMMARY

Rocket engine test facilities in the USSR containing vertical static test stands of massive construction suitable for the test firing of large liquid propellant rocket engines are divided into 3 basic groups and construction chronologies. These stands are generally located at the following 2 types of facilities: 1) complex facilities having developmental capabilities, and 2) simpler facilities that are probably mainly concerned with production-type testing.

The 3 groups of test stands are:

1) stands with various configurations constructed during the early 1950s; some of these stands were remodeled later for new testing programs;
2) stands with partial width projections started in the late 1950s;
3) stands with full width projections started in the early 1960s.

INTRODUCTION

Facilities for the static testing of large, liquid propellant rocket engines have been identified at 8 locations in western and central USSR (Figure 1). These facilities are characterized by large, massively constructed vertical test stands, smaller test stands, test cells, and associated support structures. Although no clear-cut distinction can be drawn between facilities for developmental testing and those for series production testing, it is possible that the relatively complex facilities with several test stands of varied sizes and configurations have developmental capabilities, whereas the relatively simple or less complex facilities with similar test stands are probably mainly concerned with production-type testing. However, this would not preclude development testing at the simpler facilities or, conversely, production testing at the more complex facilities. The

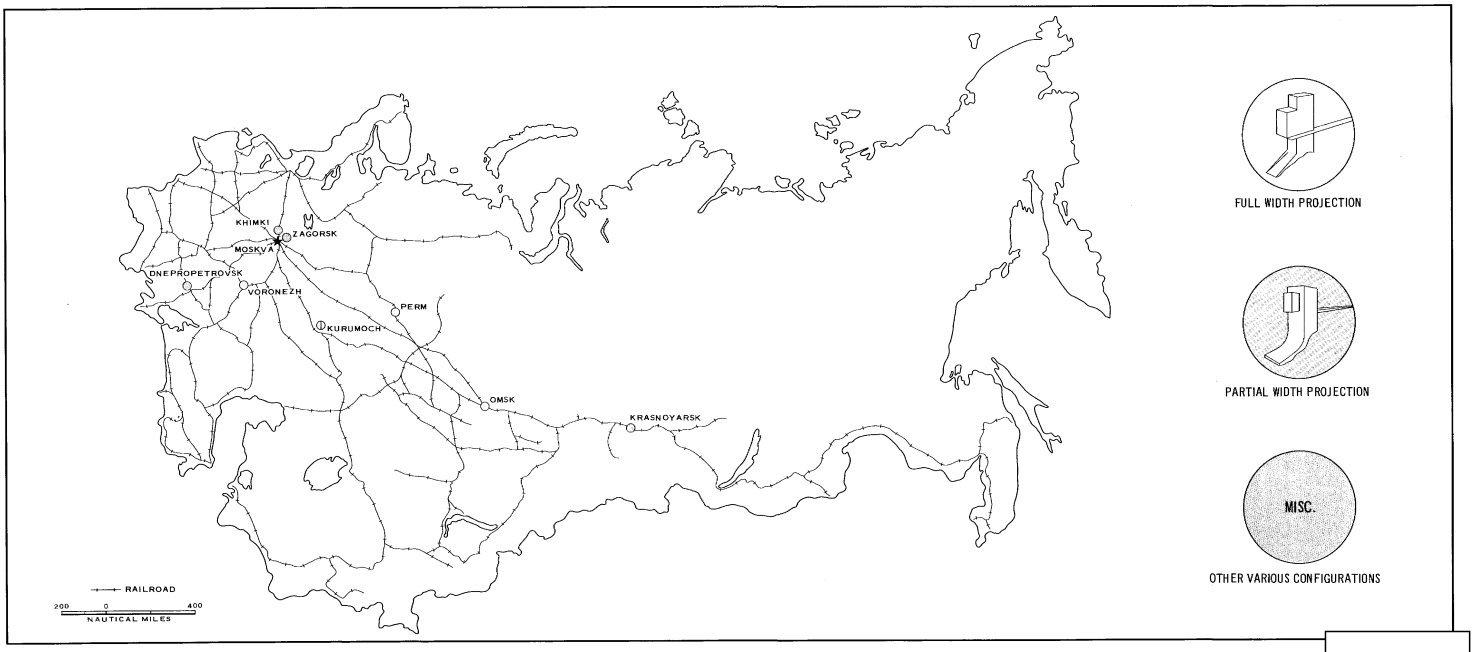


FIGURE 1. LOCATION OF LIQUID PROPELLANT ROCKET ENGINE TEST FACILITIES.

relatively complex test facilities with test stands of varied configurations have been identified at the following places:

(1) Moskva Missile and Space Propulsion Development Center Khimki 456
(55-54N 037-26E)
Moskva Guided Missile Research and Development Plant Khimki 301
55-54N 37-25E)
Both located on the northwest outskirts of Moskva

(2) Zagorsk Rocket Engine Test Facility Krasnozavodsk
(56-25N 038-10E)
Located 44 nautical miles (nm) northeast of Moskva

(3) Dnepropetrovsk Missile Development and Test Center
(48-26N 034-59E)
Located on the southern edge of Dnepropetrovsk

The relatively simple test facilities with test stands of similar configuration have been identified at the following places:

(4) Kurumoch Rocket Engine Test Facility
(53-32N 049-51E)
Located 24 nm northwest of Kuybyshev

(5) Krasnoyarsk Rocket Engine Test Facility
(56-06N 093-26E)
Located 17 nm northeast of Krasnoyarsk

(6) Perm Rocket Engine Test Facility
(58-01N 056-34E)
Located 7.5 nm east of Perm

(7) Voronezh Rocket Engine Test Facility
(51-35N 039-10E)
Located 5 nm south of Voronezh

(8) Omsk Rocket Engine Test Facility
(55-25N 073-17E)
Located 28 nm north of Omsk

GENERAL DESCRIPTION OF FACILITIES

Soviet liquid propellant rocket engine test facilities contain test stands and/or test cells which are used for the static test firing of rocket engines, small components, and possibly complete missile stages; buildings for servicing the test articles and supporting the test programs; usually an air liquefaction plant; basic utilities; administration; and housing areas. Large water storage tanks, water treatment facilities, or supply pipelines are usually evident because of the volume of water needed to cool the blast deflector.* All test facilities are secured, rail served, and situated along a ravine or cliff to utilize the natural terrain features in siting the large vertical test stands.

A detailed analysis and comparison of the larger Soviet test stands reveal marked similarities among some of them and, conversly, marked dissimilarities among others, with construction times generally coinciding with the dfferent test stand configurations. Test stands of varying appearance were built at developmental-type test facilities in the early and mid 1950s which was in the early period of the Soviet missile program. In the late 1950s, three test stands of a new configuration were started at 3 production-type test facilities. In the early 1960s, three test stands of a still newer configuration were started at 2 new production-type test facilities and 1 of the previously constructed facilities.

The large test stands near Khimki, Zagorsk, and Dnepropetrovsk were present and operational when first observed in late They were probably constructed in the early 1950s. Some, or possibly all of these stands have been remodeled to some degree as new developmental test programs were implemented, most notably those near Khimki.

Large vertical rocket engine test stands having a projection partially across the face of the stand and an access ramp into the center of the rear of the stand are located at production-type test facilities near Kurumoch, Krasnoyarsk, and Perm. The exact date when these stands were started is unknown because they were under construction when first observed on photography. However, they were probably started in the late 1950s and were all apparently completed between

Large vertical rocket engine test stands having a projection across the full width of the face of the stand and an access ramp to the side of the stand are located at production-type test facilities near Voronezh, Omsk, and Kurumoch. The earliest of these stands was started and the last was outwardly completed in

*The terms blast deflector and flame deflector are used interchangeably in this report.

MOSKVA KHIMKI PLANTS 456 AND 301

The Moskva Missile and Space Propulsion Development Center Khimki 456 is located at 55-54N 037-26E on the northwest outskirts of Moskva (Figure 2). It consists of a plant area and a test area; only the test area will be discussed in this report. Test areas of other missile-associated plants in the Khimki area are adjacent to the Plant 456 Test Area. The Moskva Aircraft Experimental Plant Khimki 293 located at 55-54N 037-27E, is adjacent to Plant 456 and is east-southeast of it. 1/ Plant 293 also consists of a plant area and a test area, but the test area does not contain large vertical rocket engine test stands and therefore will not be discussed in this report.

The Moskva Guided Missile Research and Development Plant Khimki 301 is located at 55-54N 037-25E and consists of a plant area and a test area that are approximately 1 nautical mile (nm) apart. 2/ The Plant 301 test area, adjacent to the Plant 456 test area on the northwest side, is discussed in this report. The Khimki Probable Research and Development Electronics Facility is located immediately to the southwest on the site of the former Khimki North Airfield. Plant 456 and Plant 301 are shown in Figures 3 and 4.

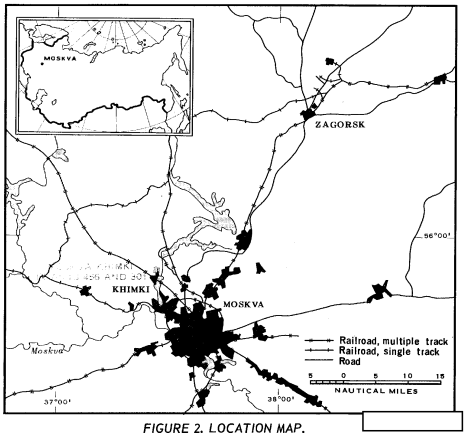


FIGURE 2. LOCATION MAP.

MOSKVA MISSILE AND SPACE PROPULSION DEVELOPMENT CENTER KHIMKI 456

The test area of the Moskva Missile and Space Propulsion Development Center Khimki 456 was not present on photography of it was visible on photography of but the poor-quality photography precluded detailed interpretation. The first interpretable photography was obtained in By referring to subsequent good-quality photography it was possible to determine that all 4 test stands (items 12, 15, 24, and 25, Figure 4 and Table 1) were present in A possible blast mark was also visible extending from the front of Test Stand No 2 (item 12). Photography of revealed construction activity near the test stand at the future site of a large circular exhaust scrubber (item 18). photography was of sufficiently good quality to permit the identification of the test stands, support buildings, and continuing construction activity near the test stands. Photography of provided the best coverage of Plant 456 obtained up to that time and permitted the identification of additional structural details of the facilities and also the continuing construction activity near the test stands. Photography of revealed an excavation at the future site of a tall exhaust stack (item 19) which was observed under construction on photography. Photography of revealed a faint plume of smoke or vapor rising from the top of this exhaust stack. Photography of showed that the circular exhaust scrubber had been roofed with reflective material. Photography of was of exceptional quality and revealed many hitherto unknown details of the test area. gave some indications of the relative age of some of the structures.

The test area of Plant 456 was probably enlarged at some date previous to as evidenced by an interior wall within the test area. The original test area would have contained Test Stands Nos 1, 2, and 4, and possibly 3; however there are indications that Test Stand No 3 may not have been in the original test area, but was included in a subsequent enlargement. The original area contains an air liquefaction plant (item 11), an administration building (item 9), a probable control building (item 13), and several support and storage buildings. In addition to these facilities, the test area currently contains a second air liquefaction plant (item 7) having an adjacent rail-served tank of unusual configuration and an associated water cooling rack (item 8). A large probable fabrication and assembly building (item 6) is in a newer part of the area. Two large support buildings (items 1, 2) have a group of overhead pipes/tanks 600 feet long under construction nearby. A recently constructed possible production building (item 16) is near the test stands. Construction activity is evident in several places in the test area, and the recent construction and alterations of the test stands are evidently in preparation for new test programs. 3/

Table 1. Description/Function, Dimensions, and Roof Cover of Structures at Plant 456 and Plant 301 (Item numbers appear in Figure 4)

Item No	Description/Function	Dimensions[a] (ft) Length	Width	Height	Roof Cover (sq ft)
Plant 456 Test Area					
1	Support bldg	200	60	30	12,000
2	Support bldg	220			
3	Lattice tower	--	--	150	--
4	Rail-served storage bldg	170	50	--	8,500
5	Lattice tower	--	--		--
6	Prob fabrication and assembly bldg	360	90	40	32,400
7	Air liquefaction plant				
8	Cooling rack				
9	Administration bldg				
10	Support bldg				
11	Air liquefaction plant				
12	Test Stand No 2				
13	Prob control bldg				
14	Support bldg				
15	Test Stand No 1				
16	Poss production bldg				
17	Support bldg				
18	Exhaust scrubber				
19	Exhaust stack				
20	Service bldg				
21	Prob storage bldg				
22	Storage shed				
23	Stack				
24	Test Stand No 3				
25	Test Stand No 4				
Plant 301 Test Area					
1A	Test Stand No 1				
2A	Prob assembly/checkout bldg				

[a] All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.

FIGURE 3. MOSKVA KHIMKI PLANTS 456 AND 301 [redacted] 25X1

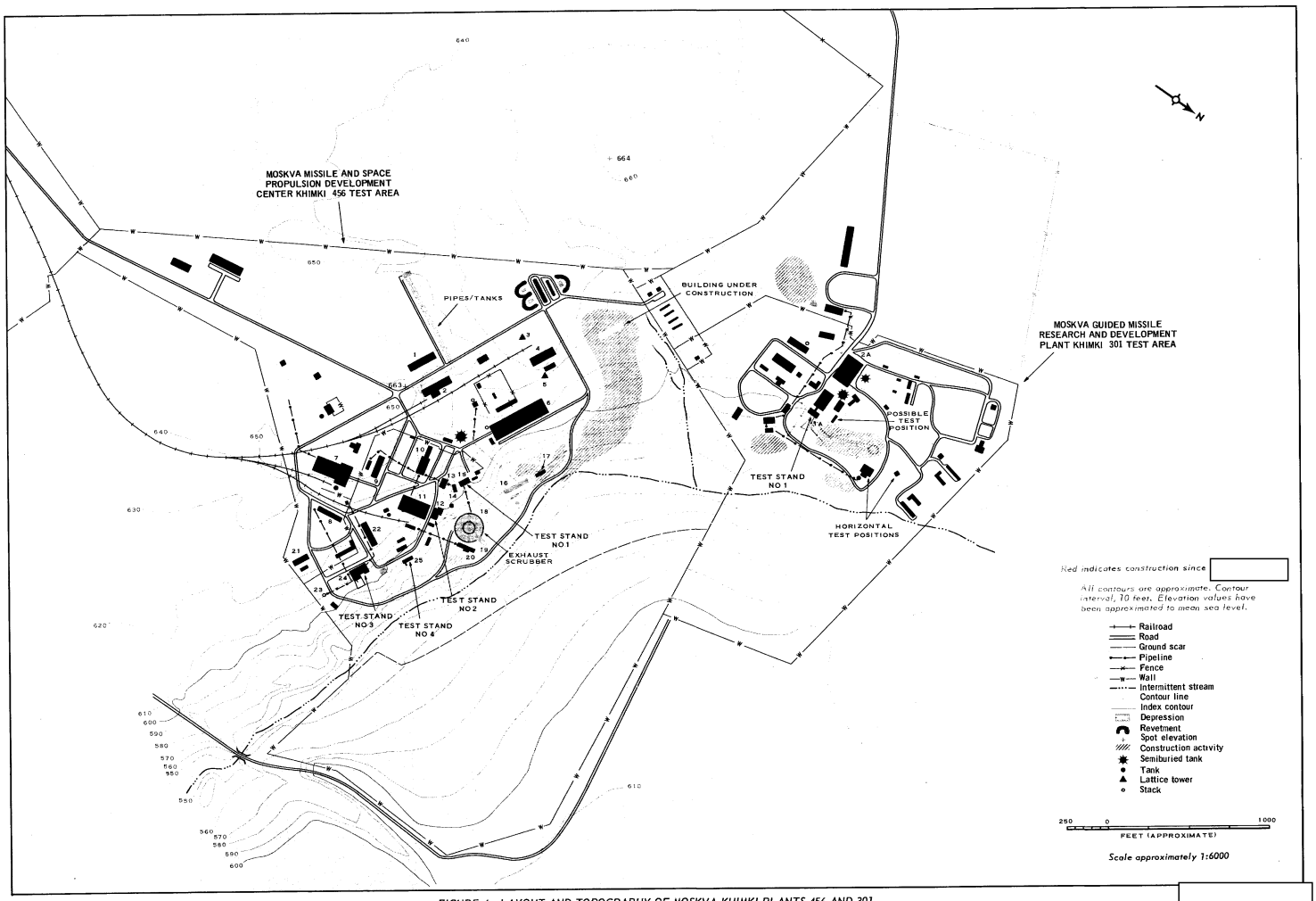
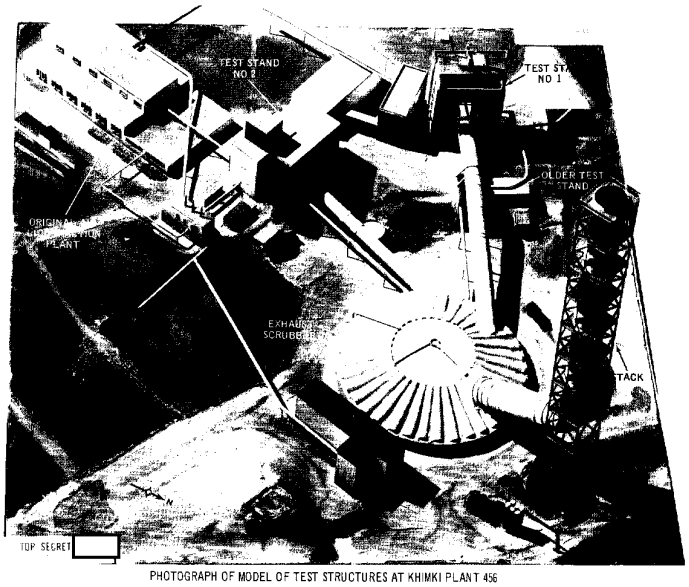


FIGURE 4. LAYOUT AND TOPOGRAPHY OF MOSKVA KHIMKI PLANTS 456 AND 301.



PHOTOGRAPH OF MODEL OF TEST STRUCTURES AT KHIMKI PLANT 456

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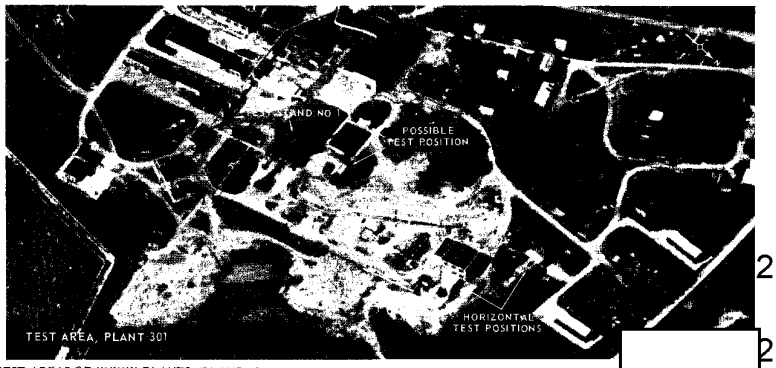

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25X1 [redacted] 25X1

FIGURE 5. STRUCTURES IN THE TEST AREAS OF KHIMKI PLANTS 456 AND 301.

The rocket engine test facilities at Khimki have apparently been remodeled and modified a number of times as new developmental programs were initiated. The varied appearances of the test stands and the unusual newly constructed facilities are indicative of a development-type facility.

Test Stands Nos 1 and 2 (Plant 456)

Test Stand No 1 (item 15) at the Plant 456 Test Area consists of a superstructure that measures by 100 feet high; the superstructure has an opening that apparently extends entirely through the structure (Figure 5). The stand was probably built between early 1960 and late 1962, almost on top of an earlier test stand that probably dates from the late 1940s - 1950s. Test Stand No 1 is connected to an exhaust scrubber (item 18, Figure 4) by a diffuser which is in diameter and appears to have one or more choke points; the choke points indicate that this stand has altitude simulation capabilities. The diffuser/vacuum aspirator was visible on photography of

Test Stand No 2 (item 12) consists of an older and a newer part. The older part is a towerlike structure which measures The structure has a brown mottled appearance on photography This portion of the stand was probably erected between the mid-1940s and early 1950s. The newer portion measures and is 50 feet high; it appears light in tone on photography. It was probably constructed after the last evidence of test firing from this stand in and before the first evidence of construction of the exhaust scrubber (item 18) in This portion of the stand was probably completed by late 1964 because photography revealed a diffuser which extends from the newer portion of the stand to the scrubber (Figure 5). One or more enlarged areas along the diffuser may be cooling sections that would be indicative of altitude simulation capabilities. An object of smaller diameter nearby may be an additional diffuser or a support for the diffuser. The original flame pit, approximately 40 feet deep, is still evident in front of this stand which is connected by overhead pipelines to the older air liquefaction plant (item 11, Figure 4), several small structures, and a service building (item 20).

The exhaust scrubber (item 18) and associated exhaust vent stack (item 19) serve both Test Stands No 1 and No 2. They are apparently designed to decontaminate toxic fumes and exhaust them into the atmosphere. This procedure would be consistent with the use of fluorine compounds. 3/

Test Stand No 3 (Plant 456)

Test Stand No 3 (item 24) probably dates from the mid-1950s. The substructure somewhat resembles test buildings at Zagorsk and Voronezh; however, a tower structure approximately is on one end of the test building, and beneath this are at least 2 and possibly 3 test positions. One of the test positions has a diffuser feet in diameter. An overhead pipeline/tank approximately 410 feet long enters the rear of the tower structure and another overhead pipeline leads from the front of the tower to the base of a stack (item 23). The arrangement of this stand bears some resemblance to the newly constructed exhaust system at Test Stands No 1 and No 2.

Test Stand No 4 (Plant 456)

Test Stand No 4 (item 25) is a multiposition stand. It probably dates from the late 1940s - early 1950s. One position has a diffuser in diameter extending from the front. The superstructure of the stand is only about above grade; however, it fronts on a bluff which is about 20 feet high.

MOSKVA GUIDED MISSILE RESEARCH AND DEVELOPMENT PLANT KHIMKI 301

The test area of the Moskva Guided Missile Research and Development Plant Khimki 301 (Figures 3 and 4) generally follows the construction pattern previously discussed for the Plant 456 Test Area except that no blast marks have been identified in the area. Considerable ground scarring was observed on photography, and additional support buildings had been constructed by the photography. photography showed that the security fence had been extended to enclose a larger area, and photography revealed new construction near the single large vertical test stand (item 1A, Figure 4; Figure 5). Two horizontal test positions and a possible test position are near the large vertical test stand.

Test Stand No 1

Test Stand No 1 (item 1A, Figure 4; Figure 5) was probably constructed in the 1950s. The superstructure is It rises from a rectangular base structure that is approximately 70 by 25 feet. The blast pit is less than directly under the superstructure and widens to approximately 40 feet. Large-diameter pipelines in a newly excavated ditch may be indicative of remodeling at this stand.

REFERENCE

MAPS OR CHARTS

ACIC series, scale 1:200,000

DOCUMENTS

1. NPIC. *Moskva Experimental Plant Khimki 293*, Sep 66 (TOP SECRET
2. NPIC. *skva Guided Missile Research and Development Plant Khimki 301*, Sep 66 (TOP SECRET
3. NPIC. *Moskva Missile and Space Propulsion Development Center Khimki 456*, Sep 66 (TOP SECRET

ZAGORSK ROCKET ENGINE TEST FACILITY KRASNOZAVODSK

The Zagorsk Rocket Engine Test Facility Krasnozavodsk (56-25N 038-10E) is located 44 nautical miles (nm) northeast of Moskva (Figure 6). It is double secured and is the largest rocket engine test facility in the USSR. The secured area comprises approximately 1.5 square nm. Additional nonsecured support and housing areas cover about 0.5 square nm. The facility was not present on photography. photography was of very poor quality, but the facility was observed to be present. It appeared to be about the same size and shape when observed on photography, which was the first photography on which details of the features were discernible. All 4 vertical test stands were observed to be present and were probably operational at that time. Structures in the original test area (Figures 7 and 8), the housing area, maintenance area, supply and storage area, and most of the facilities in the expanded test area were visible.

Between the support buildings for Test Stand No 1 were expanded. By a large support building (item 14, Figure 8 and Table 2) had been completed in the same area. photography revealed construction activity east of the expanded test area which was seen to be continuing on photography. It became apparent that this was a new possible test area under construction on photography. Three different large-scale views of the facility were obtained on photography of which provided many details of test stands and buildings heretofore unseen. photography revealed continuing construction in the possible test area.

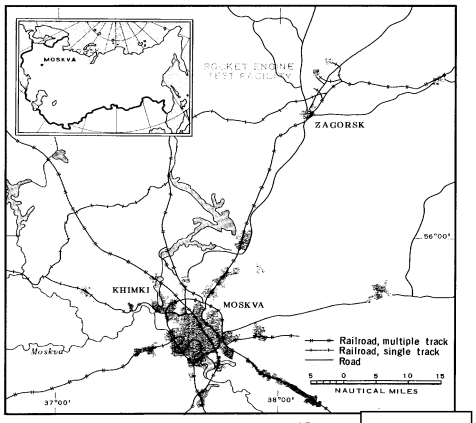

FIGURE 6. LOCATION MAP.

Dark stains have been observed in the sumps for all the test stands in the facility since However, no large dark deposits of exhaust particles on the nearby terrain have been identified; the reason for this may be the placement of the test stands along a very steep cliff with a flat flood plain at the base of the cliff.

A study of the Zagorsk Rocket Engine Test Facility reveals several structures with functions that are similar to those of structures at other test facilities in the USSR. However, no configurations that exactly duplicate structures at the other test facilities have been identified. This is undoubtedly because the Zagorsk facility is oriented toward research and development and also, perhaps, because of its early construction date. Certain unique or unusually large rocket engines may possibly be production tested at the Zagorsk facility.

ORIGINAL TEST AREA

The original test area appears to have comprised Test Stand No 1 (item 1), Test Stand No 2 (Positions A and B, items 6 and 7), Test Stand No 4 (item 4), the horizontal test building (item 3), and their support buildings. Parts of the housing area, the maintenance and supply area, and the storage area were probably also present. A ground scar and remnants of a fence seem to indicate that the test facility was expanded eastward at some date prior to

TEST STAND NO 1

Test Stand No 1 (item 1, Figure 8; Figures 9 and 10) is the largest rocket engine test stand in the USSR. It is rail served and has a superstructure which rises 160 feet above the level of an access ramp. The top of the stand is approximately 340 feet above the sump. The configuration and massive construction of this stand would make it suitable for use in testing very large liquid propellant rocket engines, clusters of rocket engines, and complete missiles and missile stages. It is similar in configuration (but not in size) to Test Stand No 3 at the Pei-ching Guided Missile Development and Production Center (PGMDPC), Chang-hsin-tien, China.* The assembly and checkout capabilities of the stand were increased between when the largest assembly/checkout building in the facility (item 13) was doubled in size to its present dimensions. A smaller assembly/checkout building (item 12) was added at about the same time. A third high-bay assembly/checkout building (item 18) was completed in

*The PGMDPC is currently being studied under NPIC Project No 11021/67.

Table 2. Description/Function, Dimensions, and Roof Cover of Structures at Zagorsk Rocket Engine Test Facility (Item numbers appear in Figure 8)

Item No	Description/Function
1	Test Stand No 1
2	Control bldg
3	Horizontal test bldg
4	Test Stand No 4
5	Assembly/checkout bldg
6	Test Stand No 2 (position A)
7	Test Stand No 2 (position B)
8	Control bldg
9	Test Stand No 3
10	Assembly/checkout bldg
11	Test position
12	Assembly/checkout bldg
13	Assembly/checkout bldg
14	Support bldg
15	Assembly/checkout bldg
16	Main gate bldg
17	Main admin bldg
18	High-bay assembly/checkout bldg
19	Cooling rack & towers
20	Prob cryogenic storage tank
21	Air liquefaction plant
22	Steamplant
23	Vehicle maintenance shed
24	Storage bldg
25	Admin bldg
26	Suspect liquid hydrogen plant
27	Cooling towers
28	Prob cryogenic storage tank
29	Support bldg
30	Support bldg
31	Bldg containing five 12-ft-diam spherical tanks
32	Poss test bldg
33	Poss test bldg
34	Support bldg
35	Support bldg

[1] All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.
[2] Approximate.

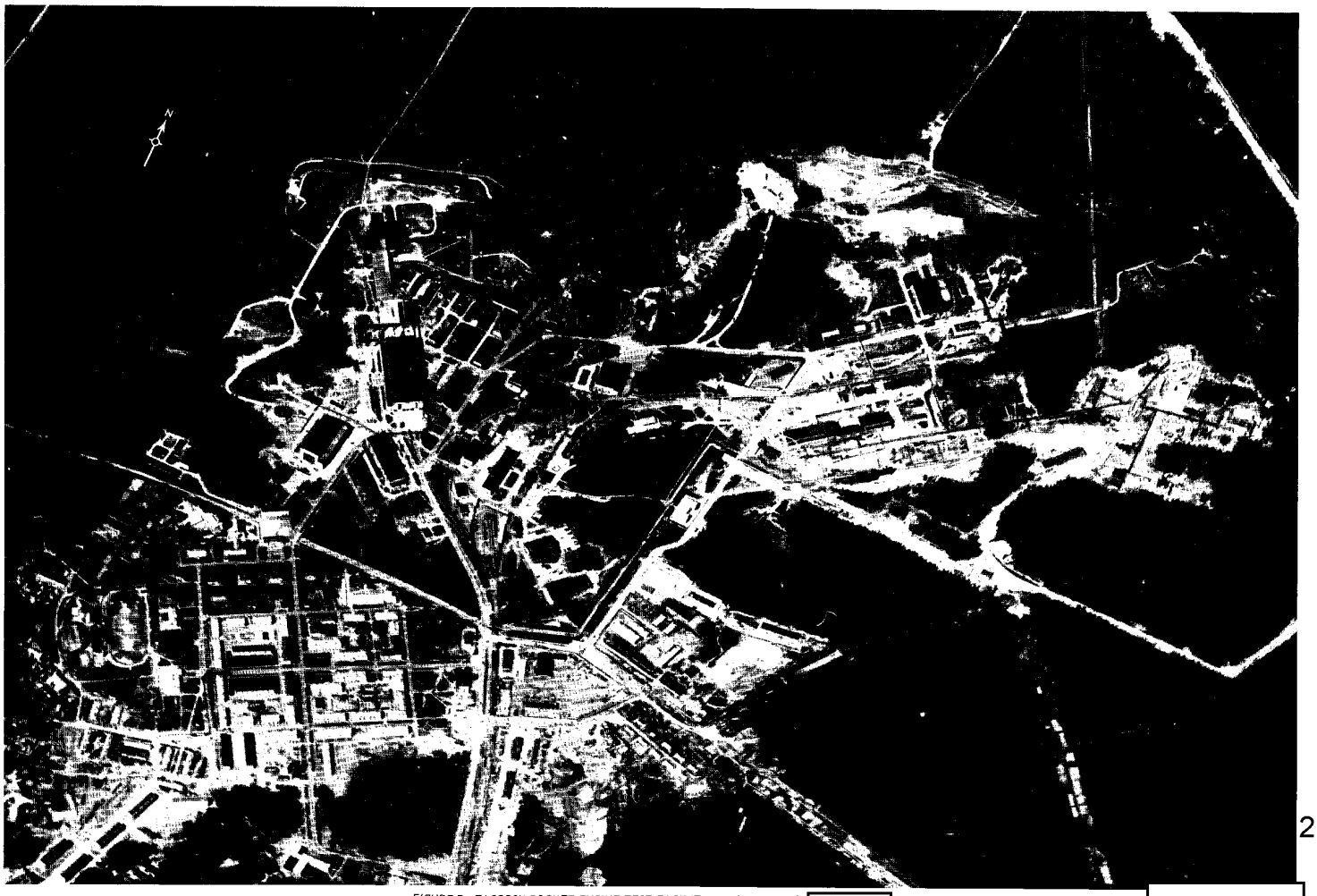

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FIGURE 7. ZAGORSK ROCKET ENGINE TEST FACILITY KRASNOZAVODSK [redacted]

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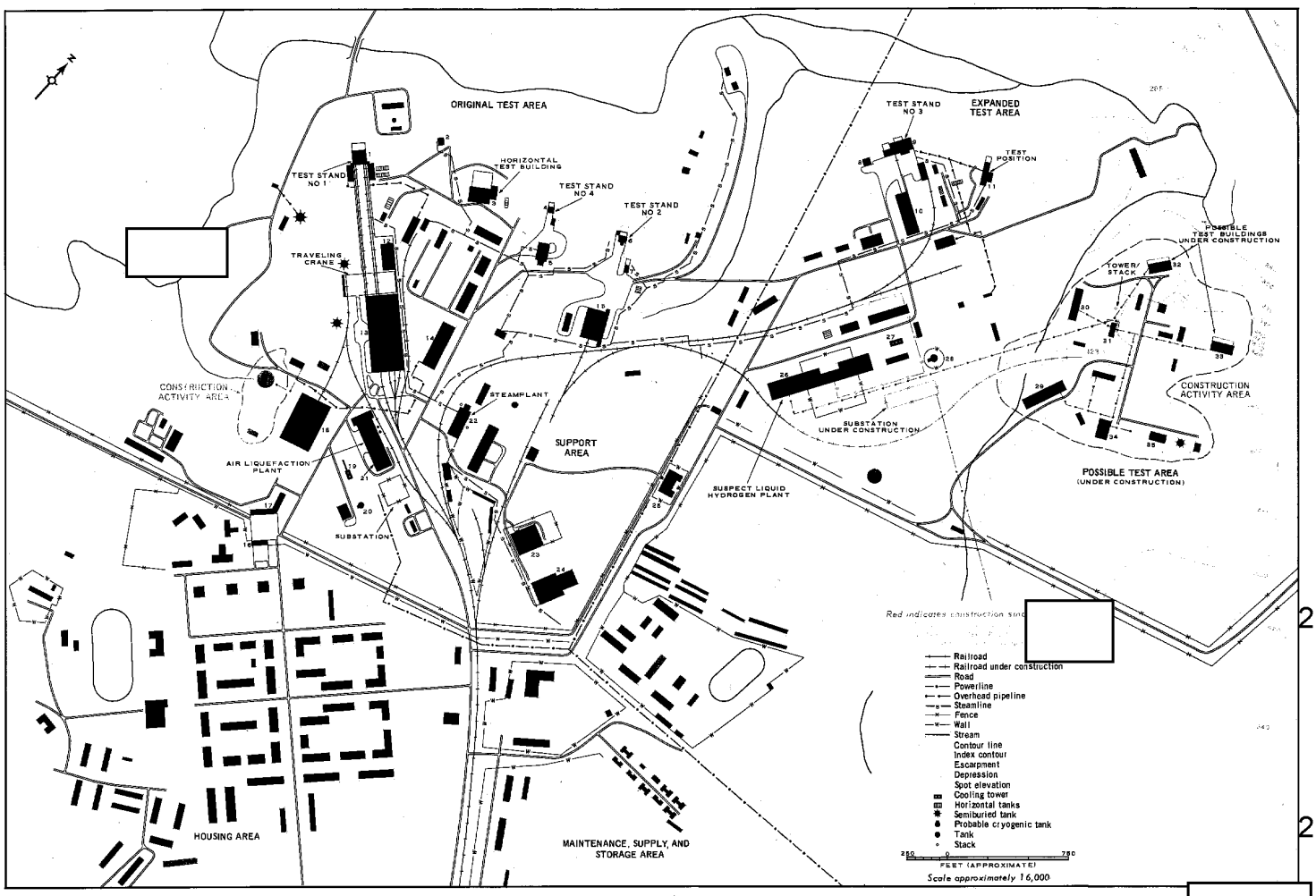

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FIGURE 8. LAYOUT AND TOPOGRAPHY OF ZAGORSK ROCKET ENGINE TEST FACILITY KRASNOZAVODSK.

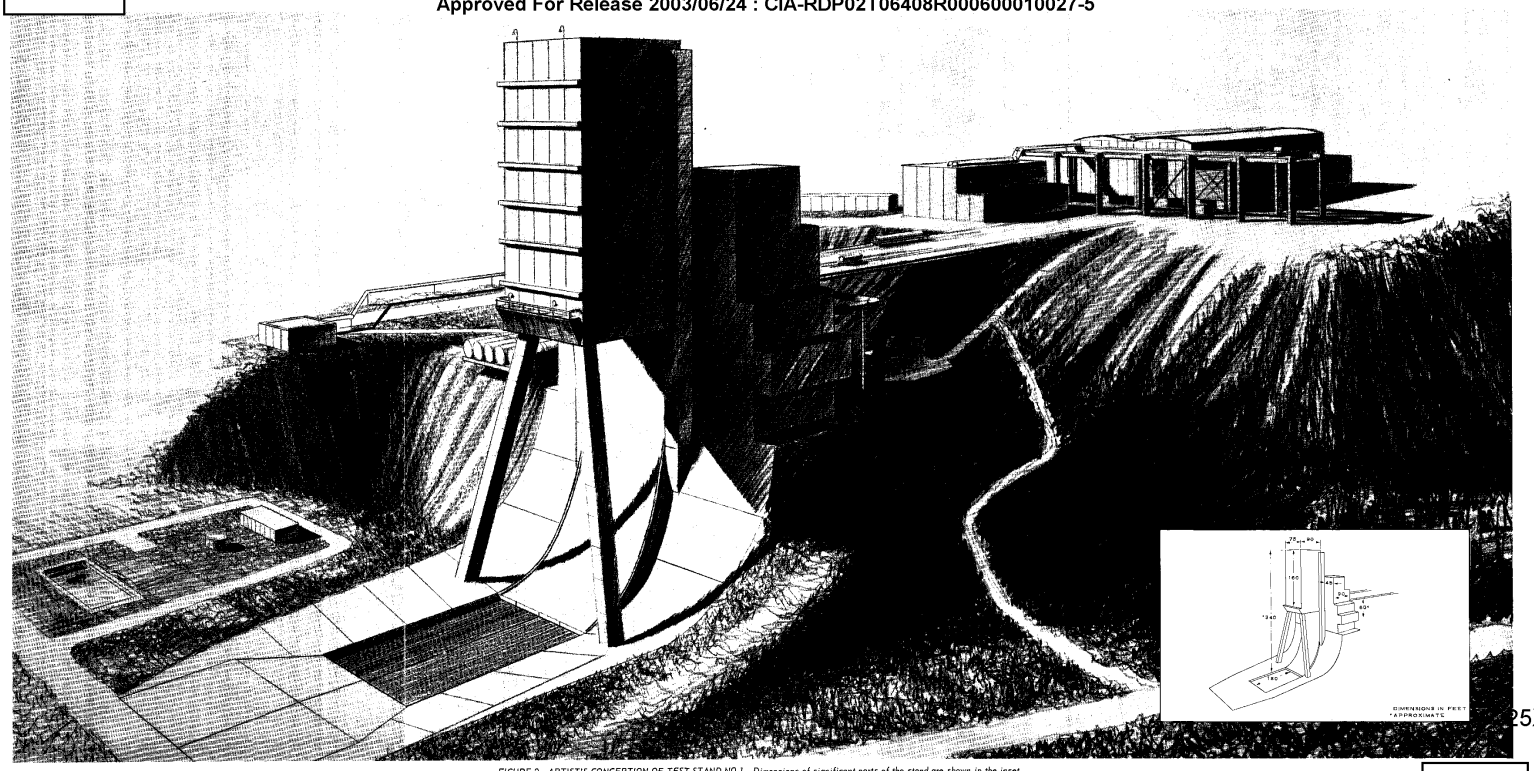

FIGURE 9. ARTIST'S CONCEPTION OF TEST STAND NO 1. Dimensions of significant parts of the stand are shown in the inset.

Construction activity and a large new tank are nearby. A control building (item 2) is situated on a bluff in order that control personnel might have an unobstructed view of the test stand.

TEST STAND NO 2

Test Stand No 2 (items 6 and 7, Figure 8; Figure 10) comprises 2 separated test positions. Position A (item 6) somewhat resembles Test Stand No 1 and is apparently designed for test firing liquid propellant rocket engines and can also probably accommodate entire missile stages. Position B (item 7) may be only a hydrostatic test position, although there are some indications of a small flame deflector at the base of the superstructure. An assembly/checkout building (item 15) serves both positions of this stand.

TEST STAND NO 4

Test Stand No 4 (item 4) is a small stand for testing rocket engines. A small support building is immediately behind the stand and an assembly/checkout building (item 5) is nearby.

HORIZONTAL TEST BUILDING

A horizontal test building (item 3) is situated near Test Stand No 1. It contains at least 2 test cells and resembles test buildings at the test facilities near Dnepropetrovsk Khimki Plant 456 and Voronezh. Components and small engines are probably test fired in this building.

EXPANDED TEST AREA

The expanded test area may have been constructed at a later date than the original test area. Test Stand No 3 (item 9), an unusual test position (item 11), and related support buildings are located in this area of expansion. Test Stand No 3 (item 9, Figure 8; Figure 11) is a rail-served, 2-position test stand. The test positions are side by side in the structure. This arrangement can be related to Test Stand No 2 at Dnepropetrovsk and Test Stand No 2 at the PGMDPC. However, the stand at Zagorsk has separate rather than contiguous blast deflectors and the western position appears smaller than the eastern one. A control building (item 8) is nearby. A probable narrow-gauge rail track extends from the stand to a nearby assembly/checkout building (item 10).

The test position (item 11) was not apparent on the [redacted] photography and was first evident on photography of [redacted] It appears to be a small test structure in which the test article is held horizontally. However, a definite conclusion in this respect cannot be made from available photography.

TEST SUPPORT AREA

The test support area contains an air liquefaction plant (item 21), associated cooling rack and towers (item 19), a probable cryogenic storage tank (item 20), a separately secured area for open storage, and several support buildings. A large secured maintenance shed (item 23) and a large storage building (item 24) occupy the southern part of the area. The test support area provides the basic utilities and services for the test facility and is directly related to the test areas.

POSSIBLE TEST AREA (UNDER CONSTRUCTION)

[redacted] photography revealed construction activity consisting of several excavations and some ground scars in an area east of the previously expanded test area and also showed a new building (item 26, suspect liquid hydrogen plant) which then consisted of the [redacted] central section which is partially secured by short security walls (Figures 8 and 11). [redacted] photography revealed construction on additions to each end of this building which increased its length to a total of [redacted] photography revealed the suspect liquid hydrogen plant to be outwardly complete and also showed continuing construction in the possible test area. The excellent quality of the [redacted] photography revealed the test area to contain 2 possible test buildings (items 32 and 33, Figure 8) which were still under construction, several support buildings (items 29, 30, 34, and 35), a tower/stack, and a row of 5 spherical tanks each [redacted] diameter which were subsequently enclosed within a building (item 31). Most of the above structures are interconnected by a pipeline that leads to the suspect liquid hydrogen plant (item 26). A bank of cooling towers (item 27), a probable cryogenic storage tank (item 28), an electric power substation which is under construction, and several other associated buildings are nearby.

The security fencing around the expanded test area has been removed, and that area and the possible test area have been included within the security fencing enclosing the important test facility structures.

Housing, maintenance and supply, and storage areas are located outside the southern and southeastern edges of the secured portions of the facility.

FIGURE 10. VIEW OF NORTHWEST PORTION OF ZAGORSK ROCKET ENGINE TEST FACILITY, [redacted]

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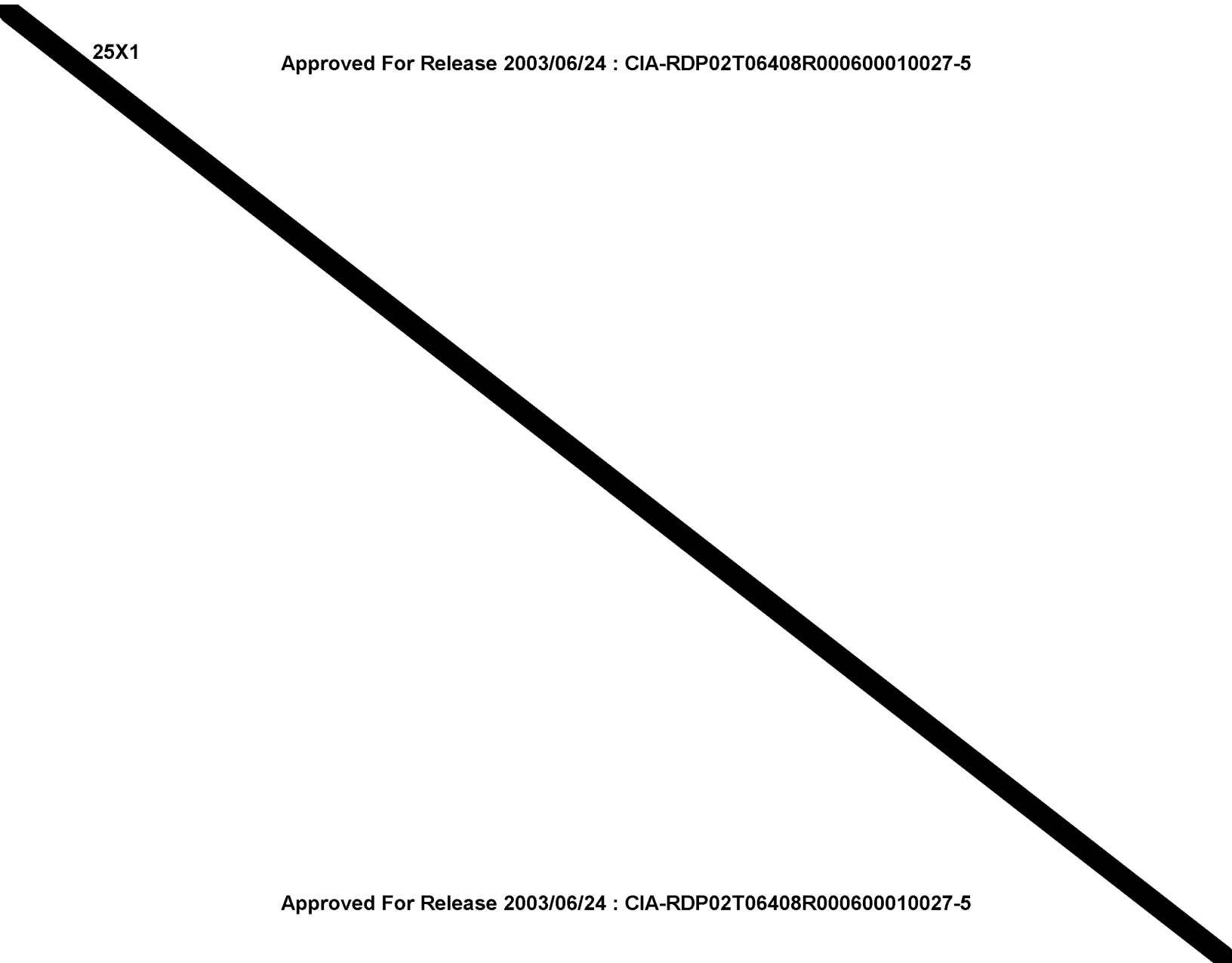
FIGURE 11. VIEW OF NORTHEAST PORTION OF ZAGORSK ROCKET ENGINE TEST FACILITY, [redacted]



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DNEPROPETROVSK MISSILE DEVELOPMENT AND PRODUCTION CENTER

The Dnepropetrovsk Missile Development and Production Center (DMDPC, [redacted] is located at 48-26N 034-59E on the southern edge of Dnepropetrovsk, USSR (Figure 12). The center consists of 3 separately secured, contiguous facilities (Figure 13), 2 of which (Plant Post Box 186 and Plant Post Box 192) are manufacturing plants. Plant Post Box 186 is the larger of the 2. The third facility is a test facility which is probably concerned with both developmental- and production-type testing of liquid propellant rocket engines, missile components, and probably complete missile systems. The test stands and structures at the test facility are unique in appearance and, although the same general types of test stands have been observed at other test facilities, none have been identified that are exactly like those at the DMDPC Test Facility. The large number and variety of test structures suggest that considerable development-type operations are performed here as well as production testing for the associated manufacturing plants.

The DMDPC Test Facility is partially double secured

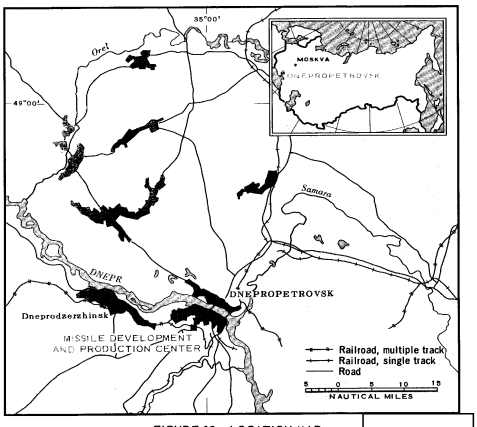

FIGURE 12. LOCATION MAP.

and is situated in a relatively flat region that has a deep natural ravine (Figures 13 and 14). The test facility was first observed on photography of [redacted] The 2 large vertical "hot firing" test stands (Test Stand No 1, item 18 and Test Stand No 2, item 16, Figure 14 and Table 3) were present at that time and earth scarring and dark stains in the blast pits indicated that testing had occurred previous to that time. Blast marks were also visible at these stands on [redacted] when the facility was snow covered. Earth scarring and burn marks were noted on photography of [redacted] An artist's conceptions of Test Stands Nos 1 and 2 are presented in Figures 15 and 16, respectively; dimensions of significant parts of each stand are also presented in these figures.

Other structures within the test facility include a number of unusual test buildings and interrelated groups of testing structures as well as associated support buildings. An [redacted] cold-flow structure (item 13, Figure 14; Figure 17) is the principal component of a probable calibration facility for testing the flow of liquids through the various parts of a missile system. A sump at the base of the structure catches the liquids, and related pumps and tanks recover, store, and probably recirculate them. A horizontal test cell building (item 12, Figure 14) that probably contains 2 or more test cells or positions is near the cold-flow test structure. Both of these test structures were present when the test facility was first observed and may be the oldest part of the facility. Test structures of a very unusual design (items 19, 20, 22, and 27, Figure 14; Figure 16) were probably constructed at a later date than Test Stands No 1 and No 2, the cold-flow structure, and the horizontal test cell building. The newer test structures appear to be concerned with calibration testing of the smaller components of rocket engines. Two probable diffuser-type tubes or possible steam accumulators indicate that one of these structures (item 27, Figure 14) may have altitude simulation capabilities; the tubes are positioned side by side at the bottom of the tower portion of the structure.

An air liquefaction plant (item 9), an associated probable cryogenic storage tank (item 10), cooling rack (item 4), and a probable cooling tower (item 5), are located in the northern part of the facility. These structures are quite similar to air liquefaction plants and their associated structures at Kharkov Liquid Oxygen Plant (49-58N 036-21E), Minsk Liquid Oxygen Plant South [redacted] 53-50N 027-32E), and Khabarovsk Liquid Oxygen Plant [redacted] 48-24N 135-07E).

TEST STAND NO 1

Test Stand No 1 (item 18, Figure 14; Figure 15) is a single-position stand for test firing liquid propellant rocket engines. The main part of the superstructure stands 80 feet above grade; a possible elevator shaft extends the total height to an additional [redacted] The stand is 90 by 80 feet in plan dimension and overhangs a curved flame deflector.

TEST STAND NO 2

Test Stand No 2 (item 16, Figure 14; Figure 16) is a 2-position stand for test firing liquid propellant rocket

Table 3. Description/Function, Dimensions, and Roof Cover of Structures at Dnepropetrovsk Missile Development and Production Center (Item numbers appear in Figure 14)

Item No	Description/Function	Dimensions[a] (ft) Length	Width	Height	Roof Cover (sq ft)
1	Suspect compressor bldg	[redacted]			
2	Storage & transfer bldg				
3	Storage & transfer bldg				
4	Cooling rack				
5	Prob cooling tower				
6	Prob production bldg				
7	Prob production bldg				
8	Storage tank				
9	Air liquefaction plant				
10	Prob cryogenic storage tank				
11	Shop & assembly bldg				
12	Horizontal test cell bldg				
13	Cold-flow structure				
14	Poss assembly/checkout bldg				
15	Assembly/checkout bldg				
16	Test Stand No 2				
17	Support bldg				
18	Test Stand No 1				
19	Prob calibration test structure				
20	Prob calibration test structure				
21	Poss structural/vibration test bldg				
22	Poss structural/vibration test tower				
23	Poss calibration test bldg				
24	Suspect test structure u/c				
25	Poss flow calibration test structure				
26	Prob calibration test structure				
27	Prob calibration test structure				
28	Suspect components test bldg				

[a] All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.

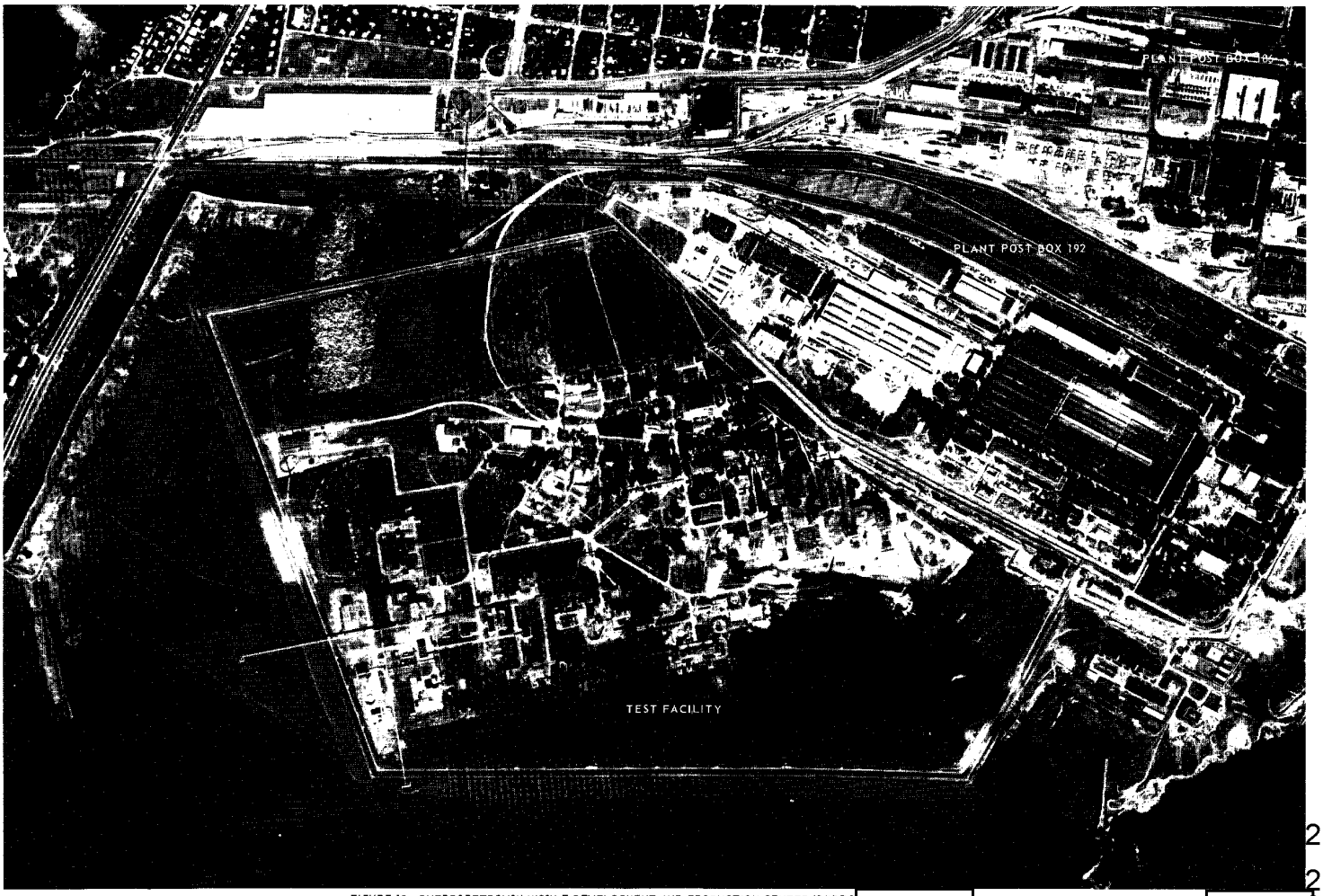

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FIGURE 13. DNEPROPETROVSK MISSILE DEVELOPMENT AND PRODUCTION CENTER (DMDPC

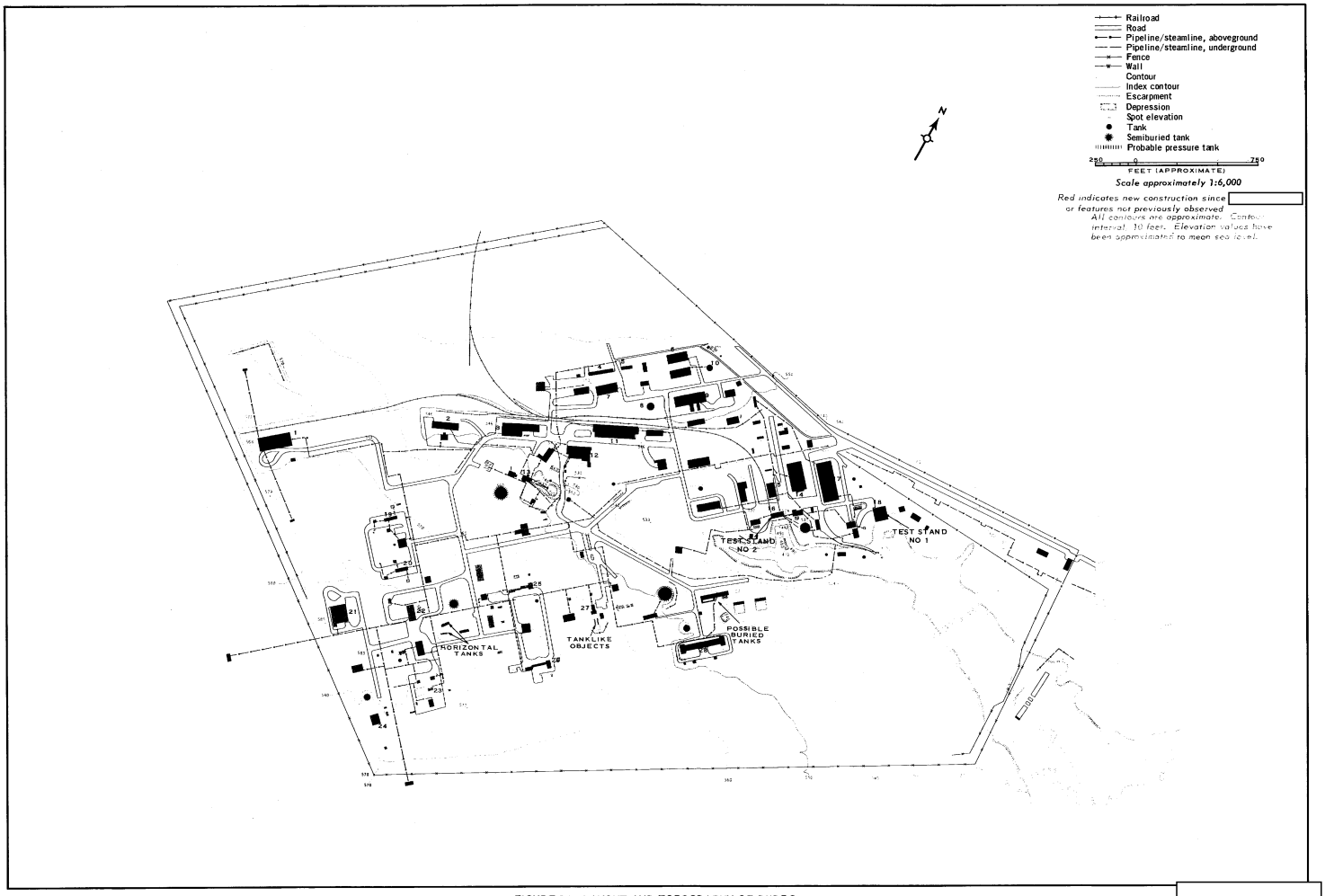

FIGURE 14. LAYOUT AND TOPOGRAPHY OF DMDPC.

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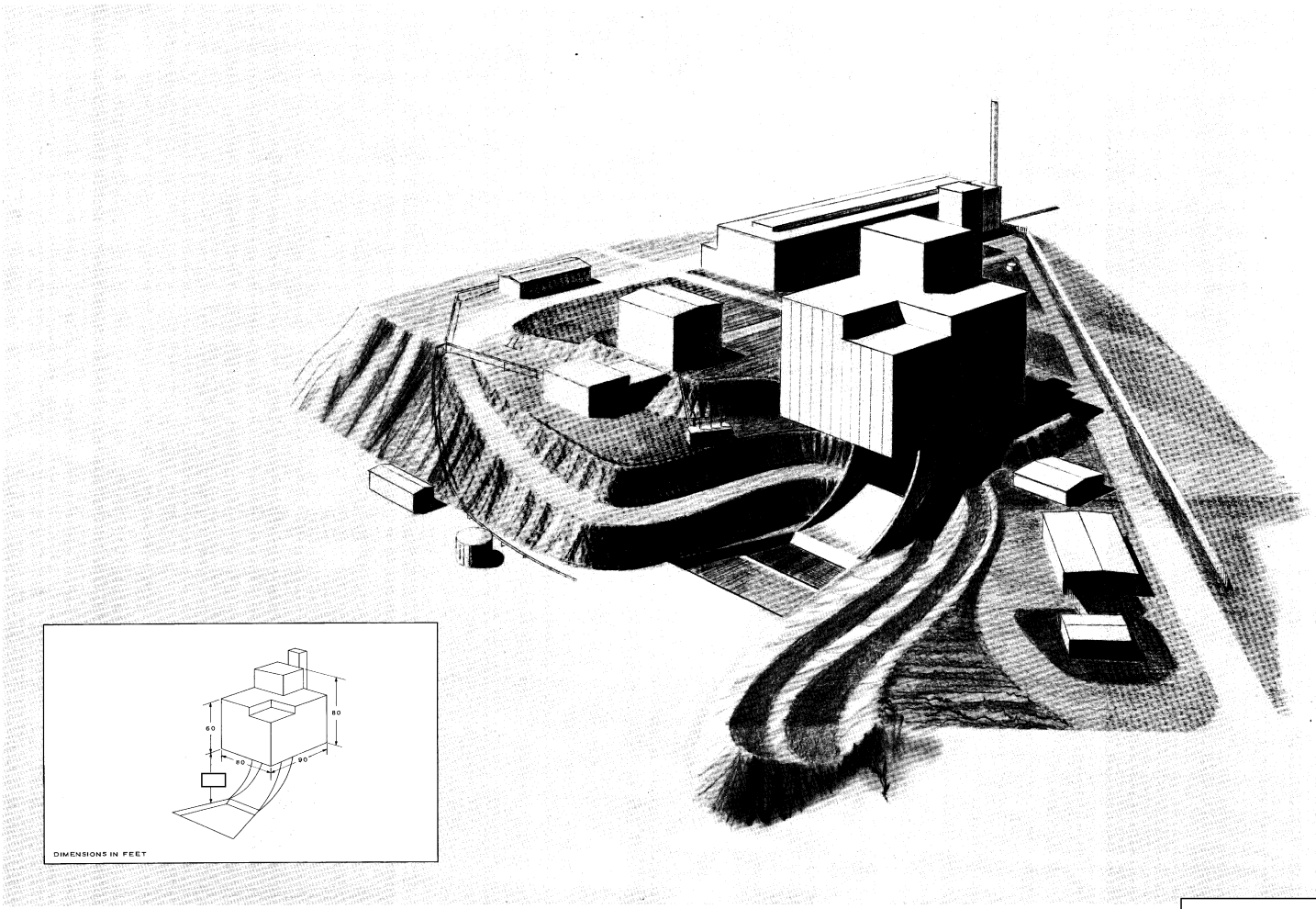

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FIGURE 15. ARTIST'S CONCEPTION OF TEST STAND NO 1. Dimensions of significant parts of the stand are shown in the inset.

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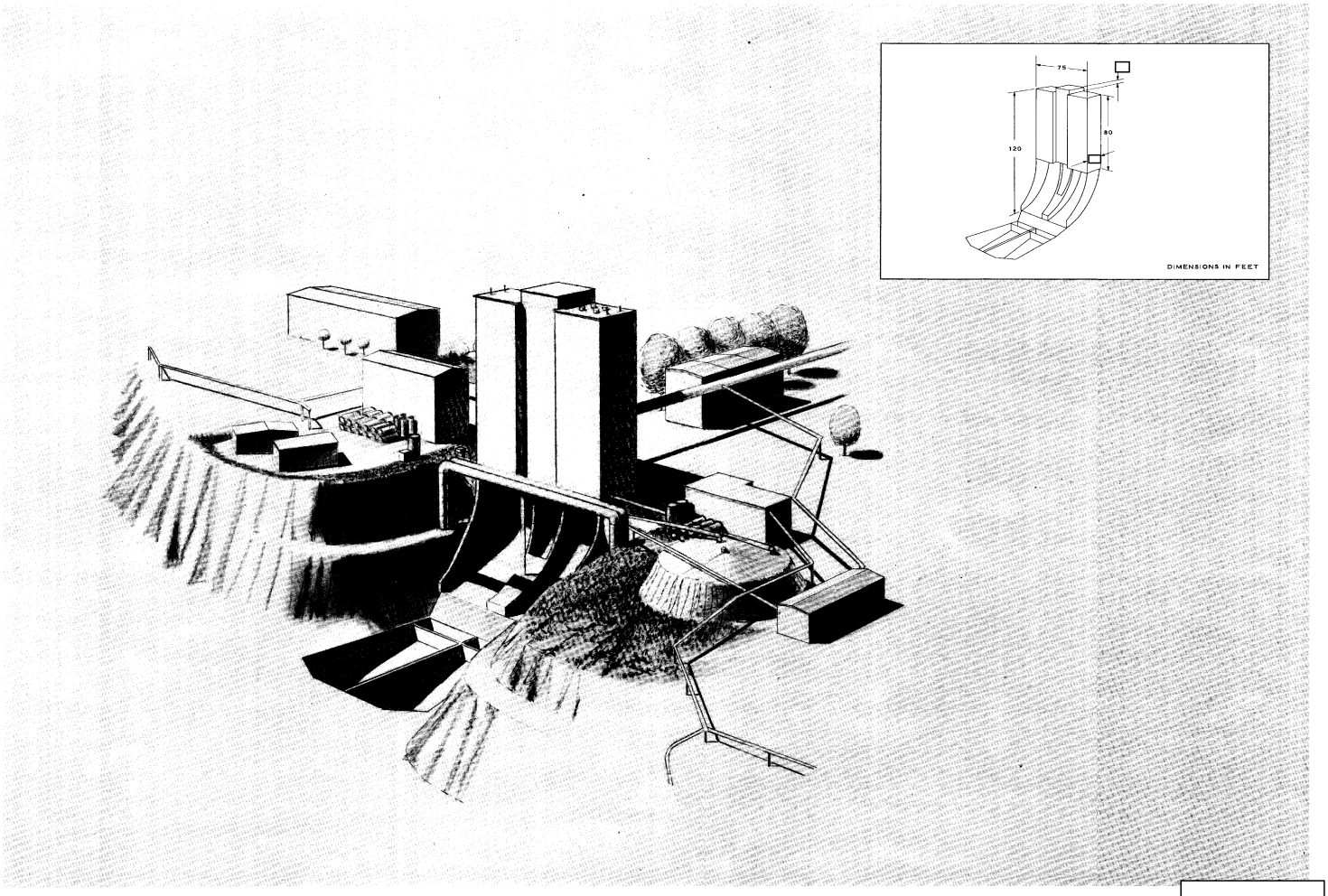

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FIGURE 16. ARTIST'S CONCEPTION OF TEST STAND NO 2. Dimensions of significant parts of the stand are shown in the inset.

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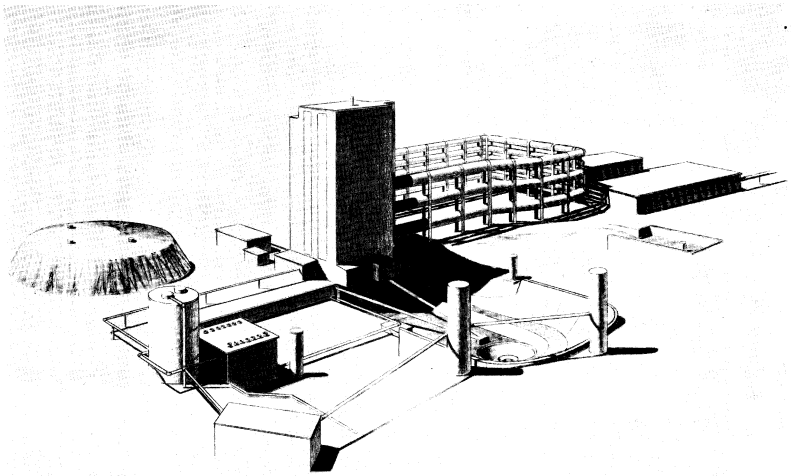
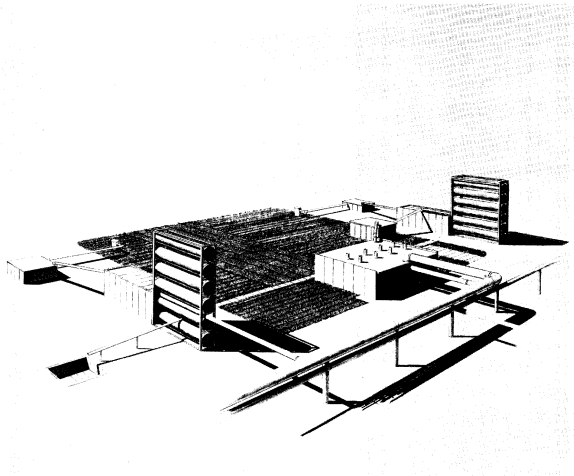
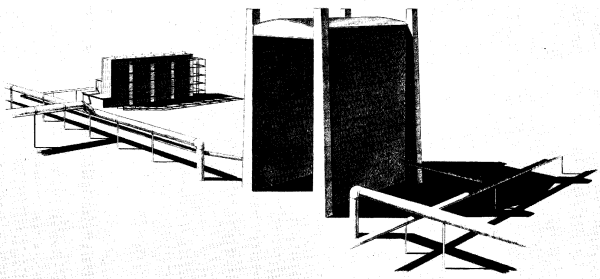


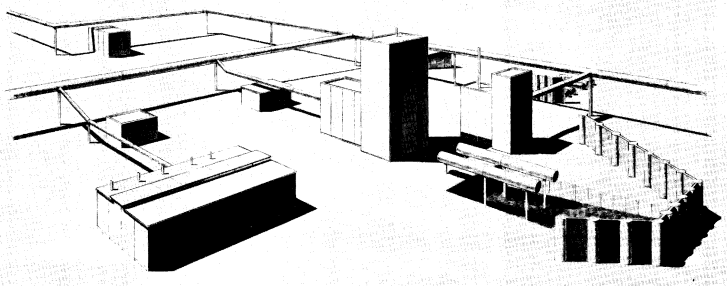
COLD-FLOW STRUCTURE (ITEM 13)



PROBABLE CALIBRATION TEST STRUCTURES (ITEMS 19 AND 20)



POSSIBLE STRUCTURAL/VIBRATION TEST TOWER (ITEM 22)



PROBABLE CALIBRATION TEST STRUCTURE (ITEM 27)

FIGURE 17. ARTIST'S CONCEPTIONS OF VARIOUS TEST STRUCTURES OF UNUSUAL DESIGN.

engines. Twin flame deflectors, possibly cooled by a pair of large, overhead water-supply pipelines, extend from the 2 firing positions to a point approximately 40 feet below grade. The superstructure of the stand is [redacted] in the center with 80-foot-high sections on either side. The plan dimensions are [redacted] An assembly/checkout building (item 15) and a possible assembly/checkout building (item 14) are nearby. 25X1 25X1

REFERENCES

25X1

[redacted]

MAPS OR CHARTS

SAC series, scale 1:200,000

COMPARISON OF FACILITIES PROBABLY MAINLY CONCERNED WITH RESEARCH AND DEVELOPMENT TESTING

A comparison of test facilities near Khimki, Zagorsk, and at the DMDPC shows that the test stands at these facilities are of varied sizes and configurations, and the related support facilities are complex and of unusual design.

Photographic data is not available to give a detailed chronology of the test stands at these facilities; however, the following table gives estimated probable construction dates based upon normal construction time periods and related historical data.

Table 4. Probable Construction and Operational Chronology of Large Test Stands at Soviet Test Facilities Probably Mainly Devoted to Development-Type Testing

Facility	Test Stand No	Negation Date	Prob Constr Period	First Observed	Test Activity First Identified	Prob Remodeling Date	Additional Remodeling
Khimki (456)	1						
	2						
	3						
	4						
Khimki (301)	1						
Zagorsk	1						
	2						
	3						
	4						
Dnepro-petrovsk	1						
	2						

KURUMOCH ROCKET ENGINE TEST FACILITY

The Kurumoch Rocket Engine Test Facility (BE No [redacted] is located at 53-32N 049-51E, 24 nm northwest of Kuybyshev, USSR (Figure 18). The facility was in an early stage of construction when first observed in [redacted] the foundation of Test Stand No 1 was approximately 60 feet above grade. [redacted] photography revealed 3 new small test stands (Test Stands 3-5) that may have been operational at that time and an excavation at the future site of a large test stand (Stand No 2, which was completed in [redacted] Blast marks have been observed at all 5 test stands on numerous occasions since [redacted] Since [redacted] a new air liquefaction plant and its associated tanks and cooling tower have been constructed at the facility to serve Test Stand No 2. The facility appeared to be complete in [redacted] photography of the facility is shown in Figure 19; the layout and topography of the facility are presented in Figure 20.

TEST STAND NO 1

Test Stand No 1 (item 27, Figure 20 and Table 5) was started prior to [redacted] and appeared to be outwardly complete in [redacted] Detailed dimensions and an artist's conception of this stand are shown in Figure 21. No evidence of test activity had been observed by [redacted] the first blast mark was seen at this stand in [redacted] Subsequent photography has revealed blast marks on at least 14 occasions. These blast marks are dark deposits on the snow in winter and burned vegetation in the summer, and they vary in size and intensity. A permanently scarred area which conformed to the size of the largest blast mark eventually developed; this is illustrated in Figure 22.

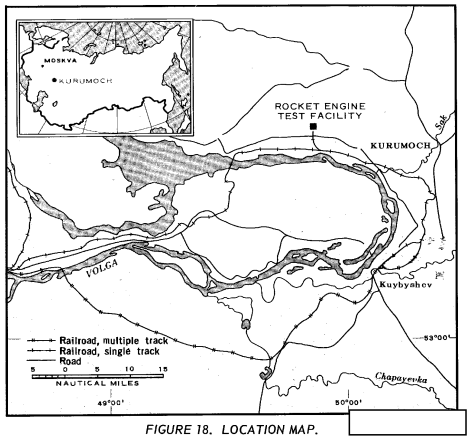


FIGURE 18. LOCATION MAP.

Test Stand No 1 is almost identical to stands near Perm and Krasnoyarsk in both its dimensions and related support structures. It appears that the flame deflector is water cooled and that the article to be tested is suspended in the [redacted] by approximately 60-foot projection which overhangs the flame deflector and partially covers the width of the test stand. Test Stand No 1 seems to be a single-position stand for testing liquid propellant rocket engines. An access ramp enters the rear center of the stand at a level [redacted] below the top of the stand and apparently also on a level with the bottom of the partial width projection. The main structure of the stand is 85 by 70 feet, rises 130 feet above grade at the rear, and extends a total [redacted] feet above the blast pit or sump. A probable narrow-gauge rail line leads from an assembly/checkout building (item 23 Figure 20) located 550 feet to the rear of the stand, across the access ramp, into the rear of the stand. A possible missile component measuring [redacted] was seen on this track in [redacted] A control building (item 26) is situated on a cliff 215 feet west of the stand and is connected to the stand by a suspended cable tray/walkway. Two cylindrical possible tanks/missile components, measuring approximately 30 by 5 feet, are also visible at the base of the stand on photography of [redacted]

TEST STAND NO 2

Test Stand No 2 (item 1) was not present on photography [redacted] In [redacted] an excavation for the test stand and an access road to the site were present in an area north of the older portion of the facility. By [redacted] the newly enlarged portion of the facility had been secured and 2 assembly/checkout buildings (items 5 and 6) had been constructed; however, the test stand appeared to be incomplete. Although in [redacted] the stand appeared to be outwardly complete, no blast mark in the snow was apparent on photography of [redacted] Detailed dimensions and an artist's conception of this stand are shown in Figure 23.

Photography of [redacted] revealed a pattern of burned vegetation and scarring that would indicate a test firing. Blast marks have been observed on several subsequent photographic missions, most notably in [redacted] when

Table 5. Description/Function, Dimensions, and Roof Cover of Structures at Kurumoch Rocket Engine Test Facility (Item numbers appear in Figure 20)

Item No	Description/Function	Dimensions[a] (ft) Length	Width	Height	Roof Cover (sq ft)
1	Test Stand No 2				
2	Control bldg for Test Stand No 2				
3	Pumphouse				
4	Poss propellant storage bldg				
5	Assembly/checkout bldg				
6	Assembly/checkout bldg				
7	Air liquefaction plant				
8	Prob cryogenic storage tank				
9	Prob cryogenic storage tank				
10	Prob cryogenic storage tank				
11	4-fan cooling tower				
12	Poss pump/compressor bldg				
13	Prob shop/fabrication bldg				
14	Rail-served support bldg				
15	Steamplant				
16	Poss storage bldg, rail served				
17	Air liquefaction plant				
18	2-fan cooling tower				
19	Prob cryogenic storage tank				
20	Prob cryogenic storage tank				
21	Prob cryogenic storage tank				
22	Assembly/checkout bldg				
23	Assembly/checkout bldg				
24	Poss components assembly/ test bldg				
25	Poss vertical tanks/ pumphouse				
26	Control bldg for Test Stand No 1				
27	Test Stand No 1				
28	Test Stand No 3				
29	Pumphouse and support bldg				
30	Test Stand No 4				
31	Control bldg for Test Stands Nos 4 and 5				
32	Test Stand No 5				
33	Shipping and receiving bldg				
34	Admin bldg				
35	Poss receiving bldg				
36	Rail-served receiving bldg				
37	Small support bldg				

[a]All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.

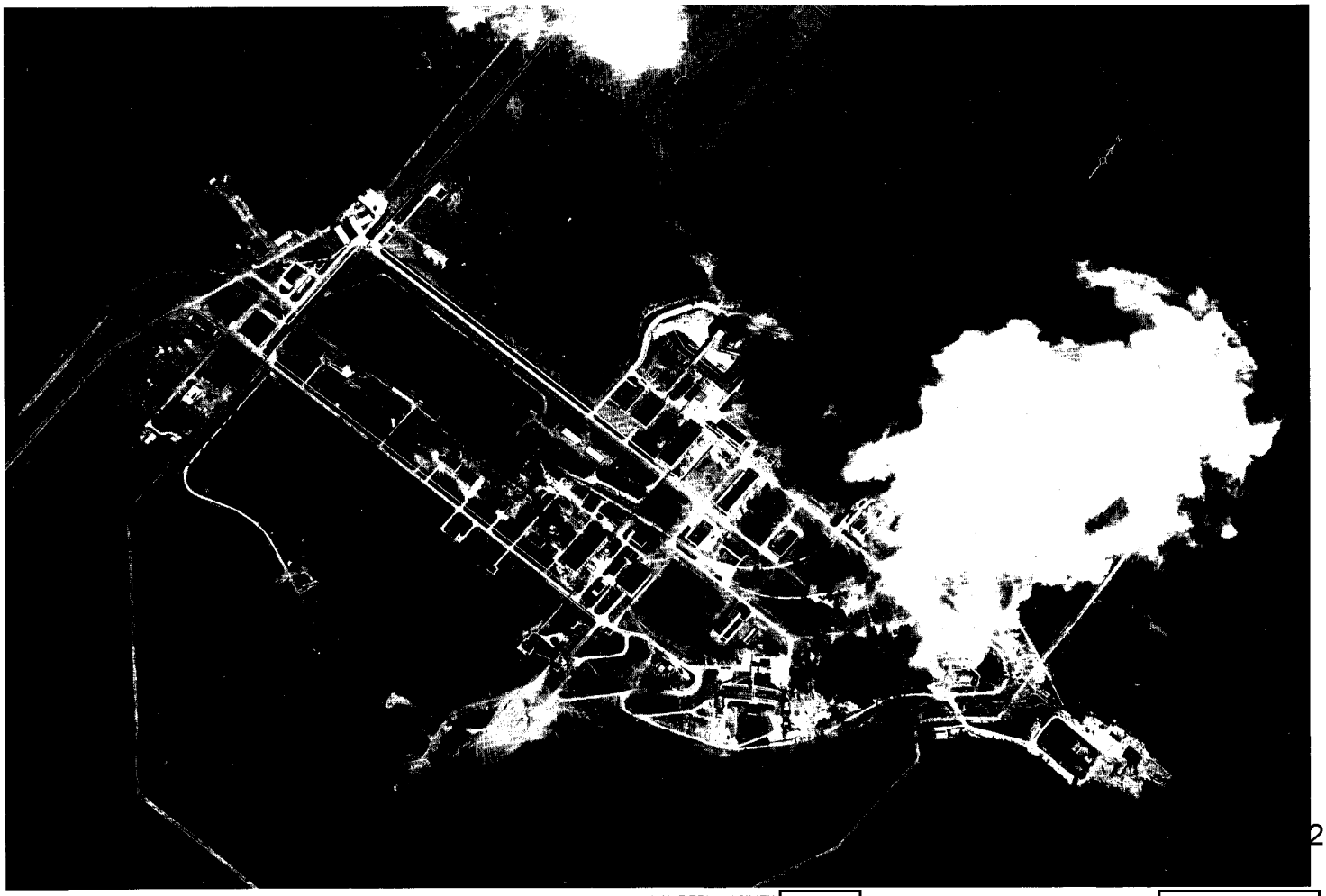


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FIGURE 19. KURUMOCH ROCKET ENGINE TEST FACILITY, [redacted]

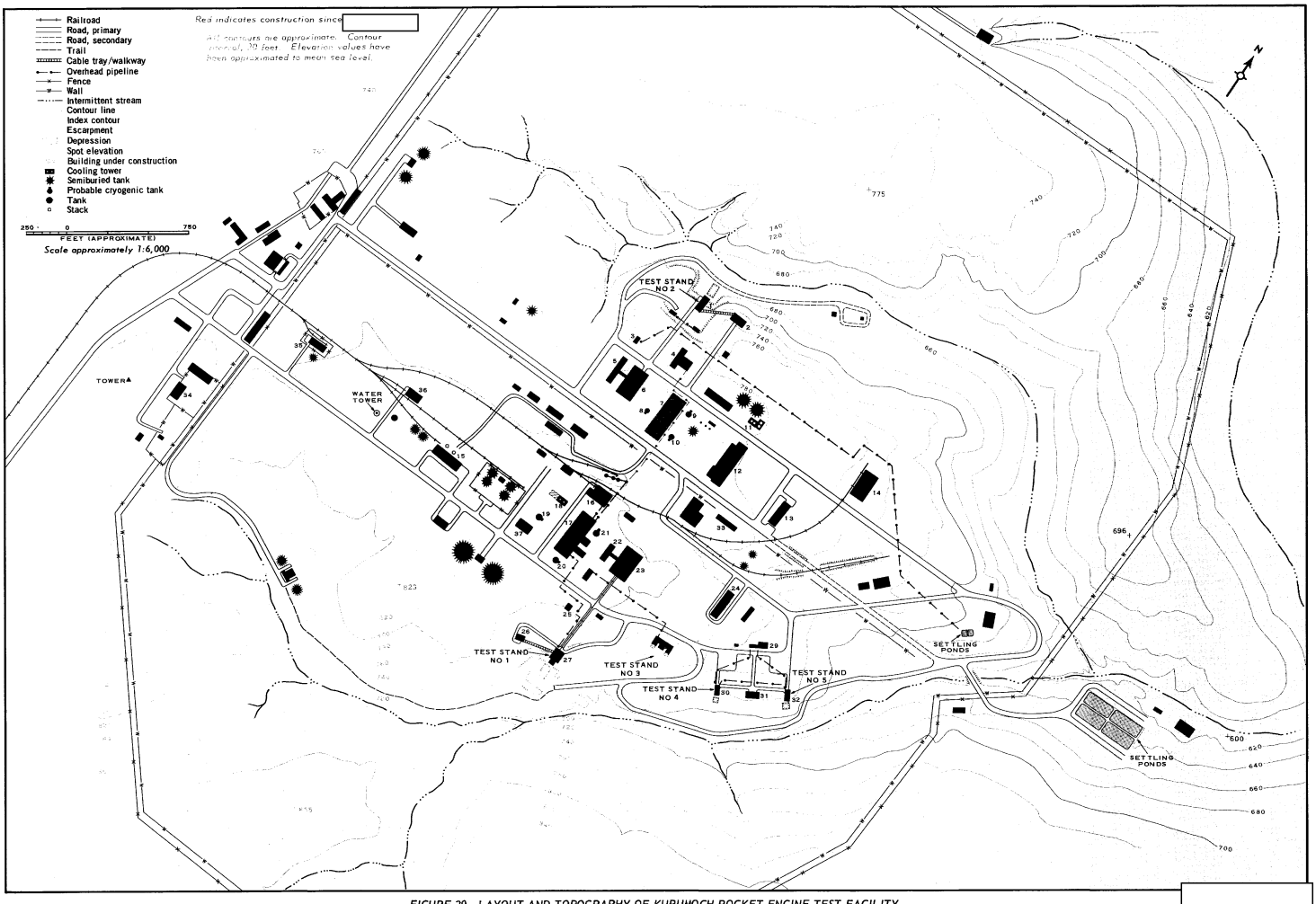

FIGURE 20. LAYOUT AND TOPOGRAPHY OF KURUMOCH ROCKET ENGINE TEST FACILITY.

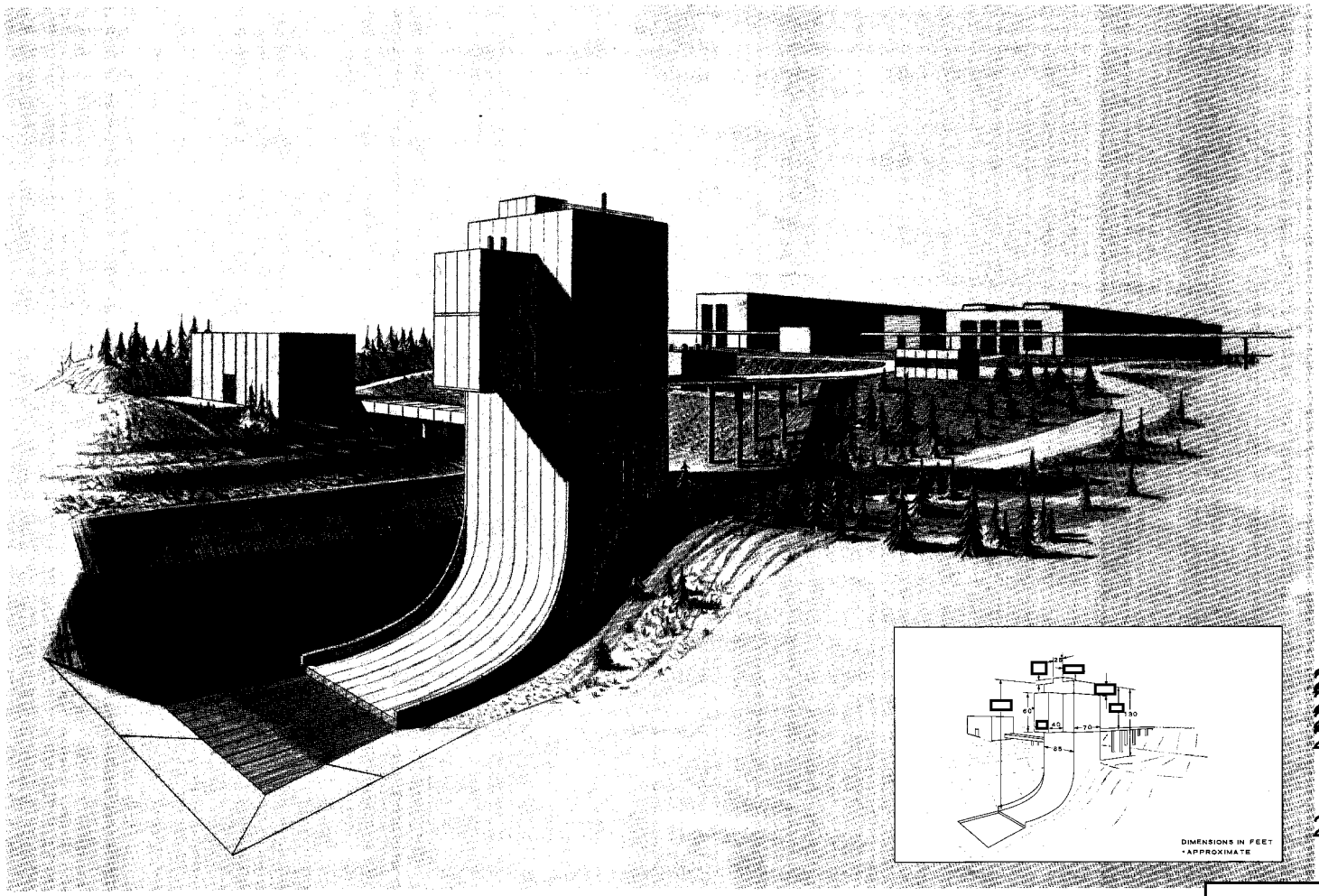

FIGURE 21. ARTIST'S CONCEPTION OF TEST STAND NO 1. Dimensions of significant parts of the stand are shown in the inset.

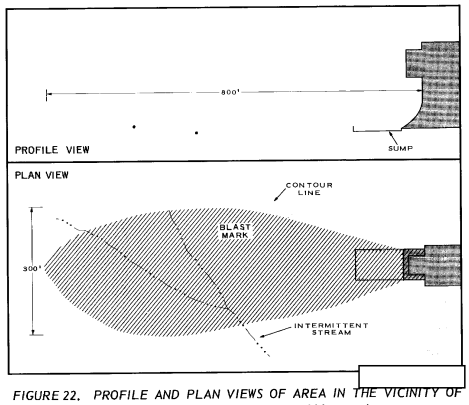

FIGURE 22. PROFILE AND PLAN VIEWS OF AREA IN THE VICINITY OF TEST STAND NO 1. These views show the extent of blast marks.

dark blast marks were observed on the snow in front of all 5 stands and in [redacted] when a very clearly defined blast mark was present at Test Stand No 2. On [redacted] an actual test was in progress on this stand at the time of the photography. A small elongated shadow which extended from the bottom of the overhanging projection of the test stand appeared to be the shadow of the downward-directed exhaust from the article being tested. The exhaust was visible as a light-toned spot directly beneath the overhanging projection and also as a fan-shaped light-toned area directed outward after the exhaust had impinged on the blast deflector. The fan-shaped exhaust pattern extends for approximately 120 feet in front of the stand and is approximately 110 feet wide. The large cloud of smoke and water vapor which is usually present before, during, and immediately after an engine test on a water-cooled test stand is not visible, possibly indicating that the exhaust might have been vapor produced by a system-purging operation.

The exhaust pattern was not present at [redacted] The exhaust pattern area was obscured by the superstructure of the test stand at [redacted] however, the shadow of the exhaust was visible. The fan-shaped exhaust pattern was visible at [redacted] is the fact that the blast marks extending beyond the test stand appeared to be identical immediately before, during, and after the test. The blast area is illustrated in Figure 24.

Test Stand No 2 is almost identical to test stands at the Voronezh and Omsk Rocket Engine Test Facilities. The flame deflector is probably water cooled and the test article is suspended in a [redacted] projection that extends across the full width of the test stand and probably contains a single position for testing liquid propellant rocket engines. An access ramp enters the side of the stand at a level [redacted] feet below the top of the stand and approximately on a level with the bottom of the overhanging projection. The highest part of the superstructure of the stand [redacted] above grade at the rear [redacted] above the blast pit or sump. An assembly/checkout building (item 6, Figure 20) is situated 295 feet south of the stand, and the control building for Test Stand No 2 (item 2) is 230 feet east of the stand. A crated possible missile component [redacted] was visible near the assembly/checkout building on [redacted] photography.

TEST STAND NO 3

Test Stand No 3 (item 28, Figure 20; Figure 25) was not present in [redacted] and was first seen in [redacted] Poor photography and the small size of the stand precluded an accurate determination of the completion date of the stand; however, it appeared outwardly complete when it was first observed. The first observed test firing was in [redacted] The stand contains 2 small probably vertical test positions separated by a control section. The entire test stand extends for 135 feet along a 70-foot-deep embankment. The tops of the test cells are [redacted] above grade. Small blast pits are located beneath each test position.

TEST STANDS NO 4 AND NO 5

Test Stands No 4 and No 5 (items 30 and 32, Figure 20; Figure 26), not present in [redacted] were first seen [redacted] when they appeared to be completed. Although blast marks were observed at both stands in [redacted] and on numerous subsequent occasions, Test Stand No 5 has shown the most activity. The 2 stands are nearly identical and closely resemble the configuration of the Kurumoch Test Stand No 2.

Test Stand No 4 is 60 by 35 feet and rises 70 feet above grade. It has a high superstructure and a full width projection quite similar to Test Stand No 2. Test Stand No 5 is 70 by 35 feet and rises for about 70 feet above grade. Small sumps are in front of each test stand and a control building (item 31, Figure 20) is situated between the stands. Vehicles pulling a slightly tapered possible missile component/propellant carrier, [redacted] were visible near these stands and near the older of the 2 air liquefaction plants (item 17) on [redacted] photography.

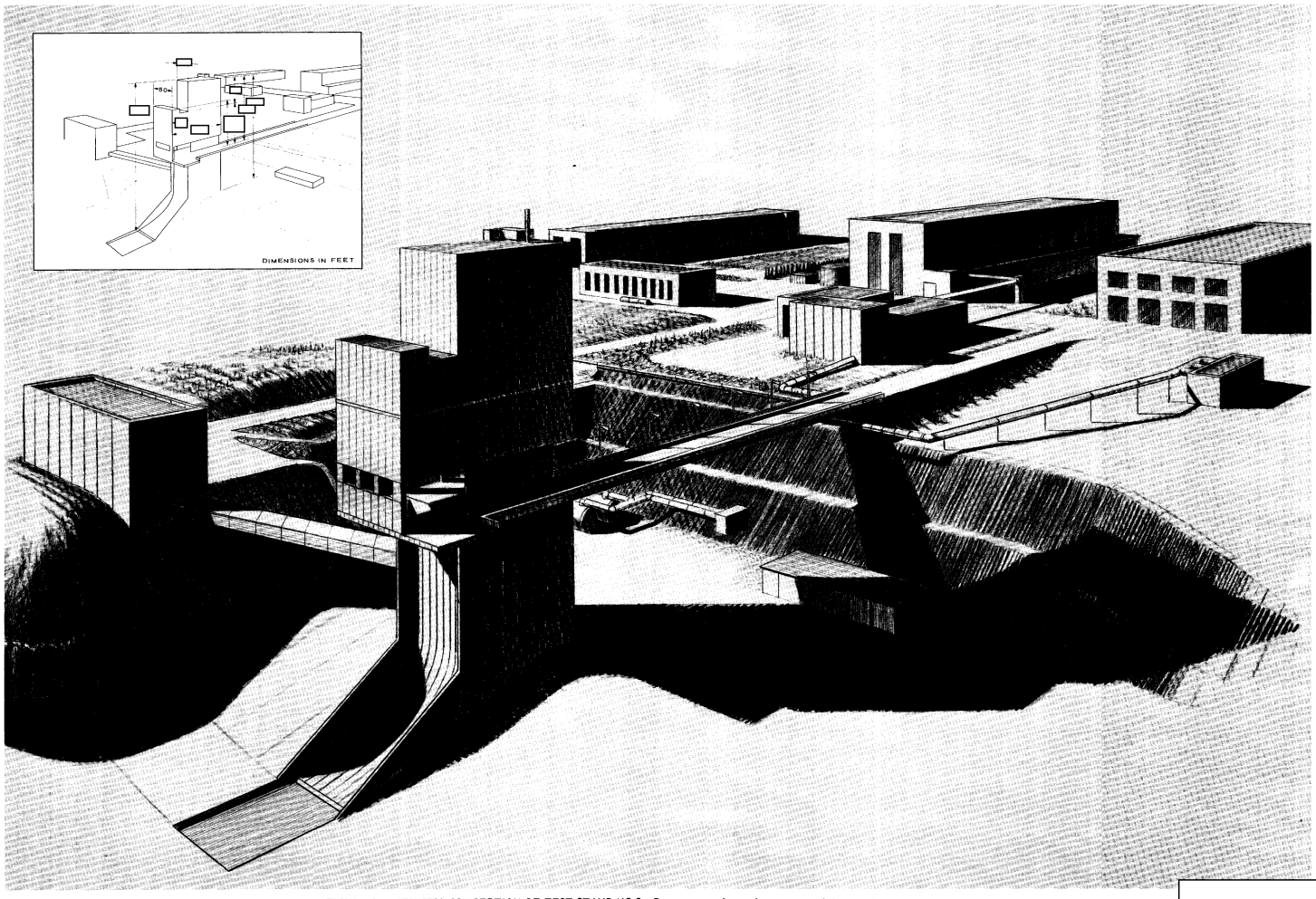

FIGURE 23. ARTIST'S CONCEPTION OF TEST STAND NO 2. Dimensions of significant parts of the stand are shown in the inset.

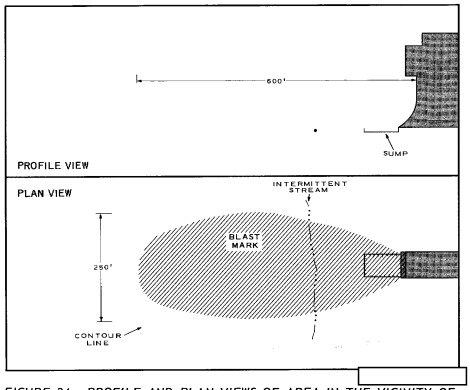

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FIGURE 24. PROFILE AND PLAN VIEWS OF AREA IN THE VICINITY OF TEST STAND NO 2. These views show the extent of blast marks.

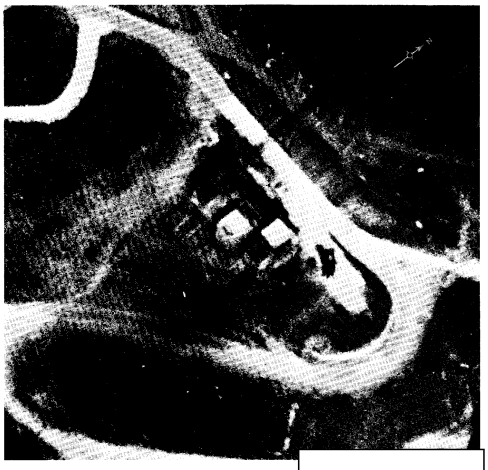

FIGURE 25. TEST STAND NO 3, [redacted]

FIGURE 26. TEST STANDS NO 4 AND NO [redacted]

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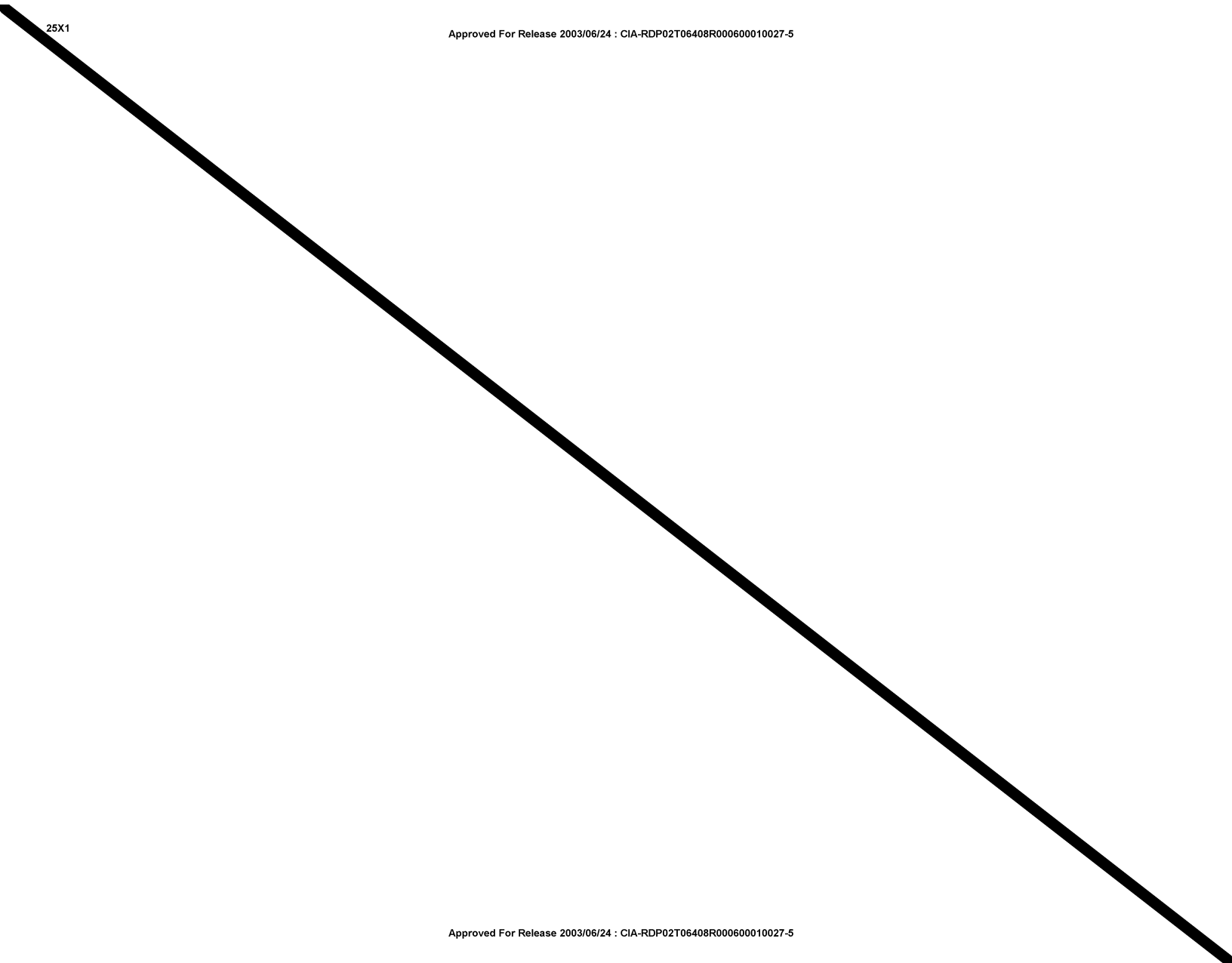
25X1 [redacted] 25X1



KRASNOYARSK ROCKET ENGINE TEST FACILITY

The Krasnoyarsk Rocket Engine Test Facility (BE No [redacted]) is located at 56-06N 093-26E, 17 nm northeast of Krasnoyarsk, USSR (Figure 27). A double fence secures the site. The facility was not present on photography of [redacted] although some scarring was evident in the vicinity. The facility was visible on photography of [redacted], but poor quality precluded a determination of the construction status. [redacted] photography permitted the identification of a large test stand (Test Stand No 1) and several support buildings. However, the facility appeared to be still under construction. A photograph of the facility, taken in [redacted], is shown in Figure 28; the layout and topography of the facility are shown in Figure 29.

Test Stand No 1 (item 9, Figure 29 and Table 6) was completed in [redacted] and testing was probably in progress by early 1964. Since [redacted] a second test stand has been added to the facility. No evidence of test activity has been observed at the second stand as of [redacted]

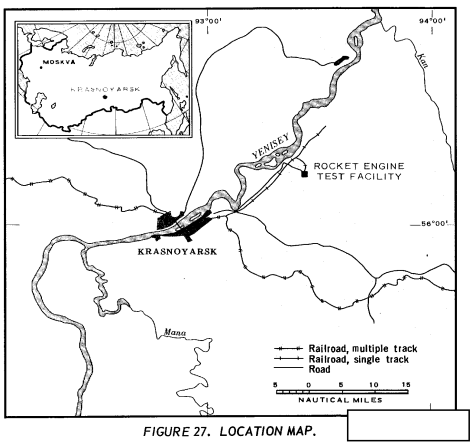


FIGURE 27. LOCATION MAP.

A large air liquefaction plant (item 10, Figure 29), associated probable cryogenic storage tanks (items 11, 12), and a cooling rack (item 15) are located approximately 550 feet from Test Stand No 1. Two small tanks of unusual configuration are adjacent to the west side of the plant. A possible fuels processing/fabrication facility (item 21) with tall stacks protruding above the roof is connected by pipelines to 2 possible propellant unloading buildings (items 23, 25). Two identical rail-served possible storage buildings (items 18, 22), a steamplant (item 19), a substation, storage tanks, and several other structures are situated in the center of the site.

TEST STAND NO 1

Test Stand No 1 (item 9) was present on [redacted] photography, but was not readily identifiable as a test stand until [redacted] Construction was probably in its final stages in [redacted] and the stand appeared to be complete in [redacted] At that time, a discoloration was evident in the sump; however, no definite blast mark was visible. Photography of [redacted] revealed possible blast marks on the flame deflector and in the sump. Photography of [redacted] was of sufficiently good quality to reveal the general configuration and siting of the stand. Stains on the flame deflector and in the sump were visible on photography of [redacted]

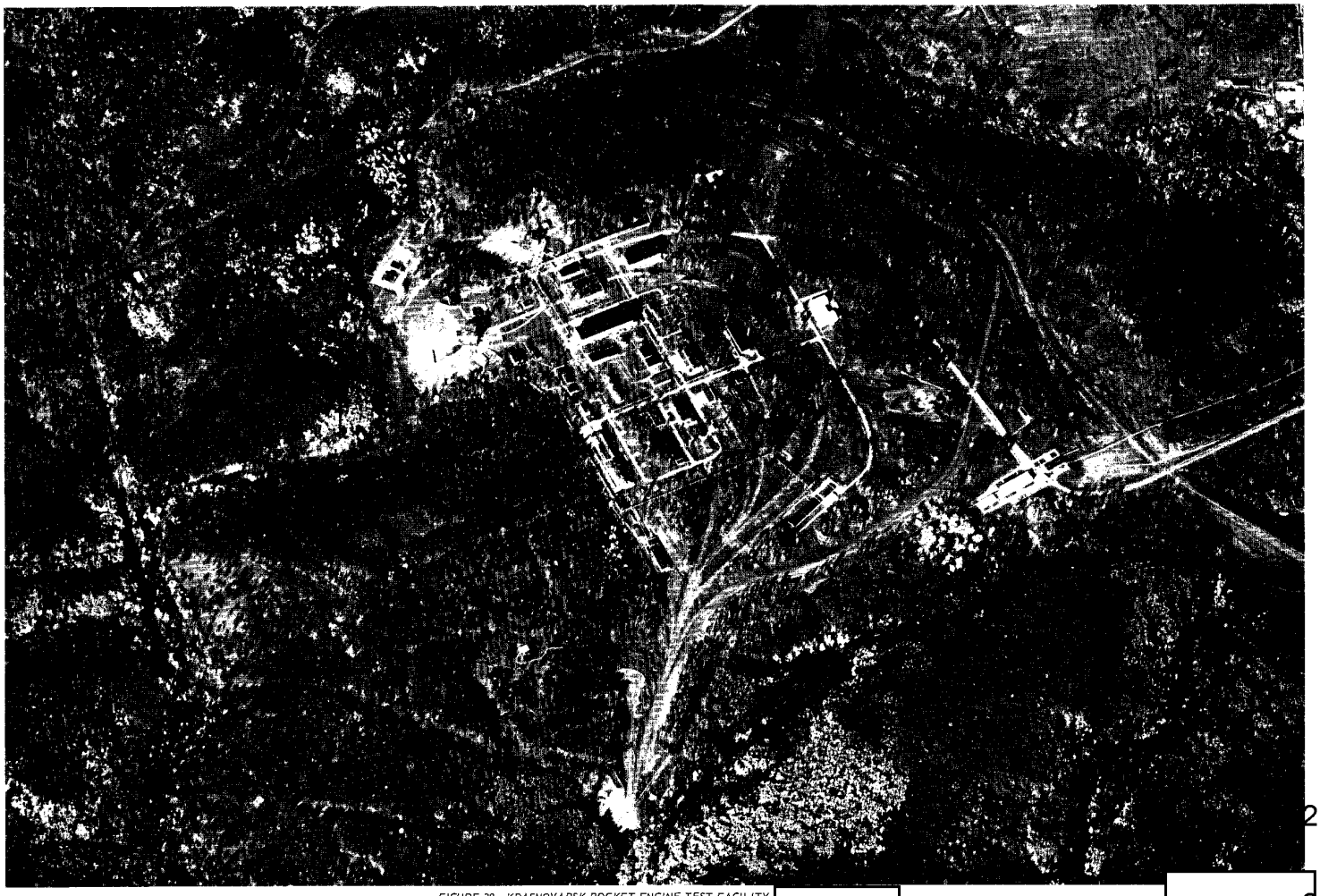
In [redacted] an unusual pattern of stains and melted snow was visible on the flame deflector and in the sump, but there was no evidence of blast marks on the surrounding terrain. In [redacted] the hillside surrounding the flame deflector and sump was eroded and scarred, but no appreciable scarring was discernible on the hillside opposite the test stand. This is probably because the flame deflector and sump are positioned midway down the hillside, as shown in the profile and plan views in the area of the test stand (Figure 31), rather than at the bottom of the hill.

Test Stand No 1 is very similar to test stands at Kurumoch and Perm; however, the test stand is sited differently from the stands at those locations. The stand at Krasnoyarsk is built into the slope to a greater degree and is therefore less freestanding. An artist's conception of Test Stand No 1 is presented in Figure 30; the inset in the figure shows dimensions of the principal parts of the structure. The article to be tested is suspended in the projection which overhangs the flame deflector and partially covers the width of the test stand; the projection measures [redacted] feet high. The stand is a single-position stand for testing liquid propellant rocket engines. An access ramp spans the narrow gap between the stand and the cliff and enters the center of the rear of the stand at a level approximately [redacted] below the top of the stand and apparently near the level of the bottom of the overhanging projection. The main structure of the stand measures 85 by 70 feet and rises approximately [redacted] above grade at the front and 205 feet above the sump. A control building (item 7, Figure 29) is situated on a bluff approximately 550 feet west of the stand. A

Table 6. Description/Function, Dimensions, and Roof Cover of Structures at the Krasnoyarsk Rocket Engine Test Facility (Item numbers appear in Figure 29)

Item No	Description/Function	Dimensions* (ft) Length	Width	Height	Roof Cover (sq ft)
1	Prob well and pumphouse	[redacted]			
2	Test Stand No 2				
3	Prob control bldg for Test Stand No 2				
4	Assembly/checkout bldg				
5	Assembly/checkout bldg				
6	Prob assembly bldg				
7	Control bldg for Test Stand No 1				
8	Small prob propellants storage bldg				
9	Test Stand No 1				
10	Air liquefaction plant				
11	Prob cryogenic storage tank				
12	Prob cryogenic storage tank				
13	Poss storage bldg				
14	Support bldg				
15	Cooling rack				
16	Poss workshop				
17	Poss storage bldg				
18	Rail-served poss storage bldg				
19	Steamplant				
20	Admin bldg				
21	Poss fuels processing/ fabrication facility				
22	Rail-served poss storage bldg				
23	Poss propellant unloading bldg				
24	Transloading and storage bldg				
25	Poss propellant unloading bldg				
26	Admin bldg				

*All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.



25X1

FIGURE 28. KRASNOYARSK ROCKET ENGINE TEST FACILITY,

25X1

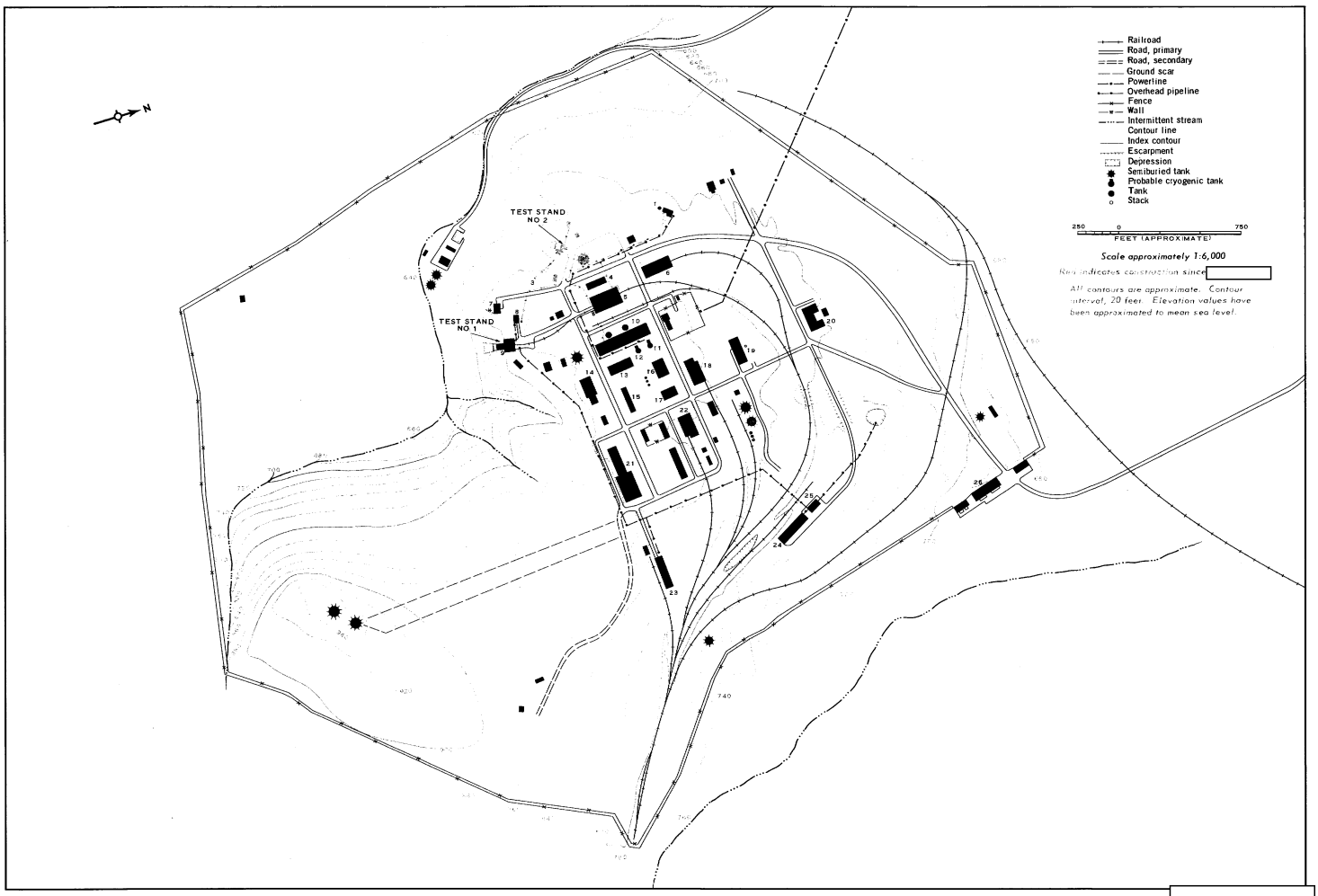


FIGURE 29. LAYOUT AND TOPOGRAPHY OF KRASNOYARSK ROCKET ENGINE TEST FACILITY.

25X1

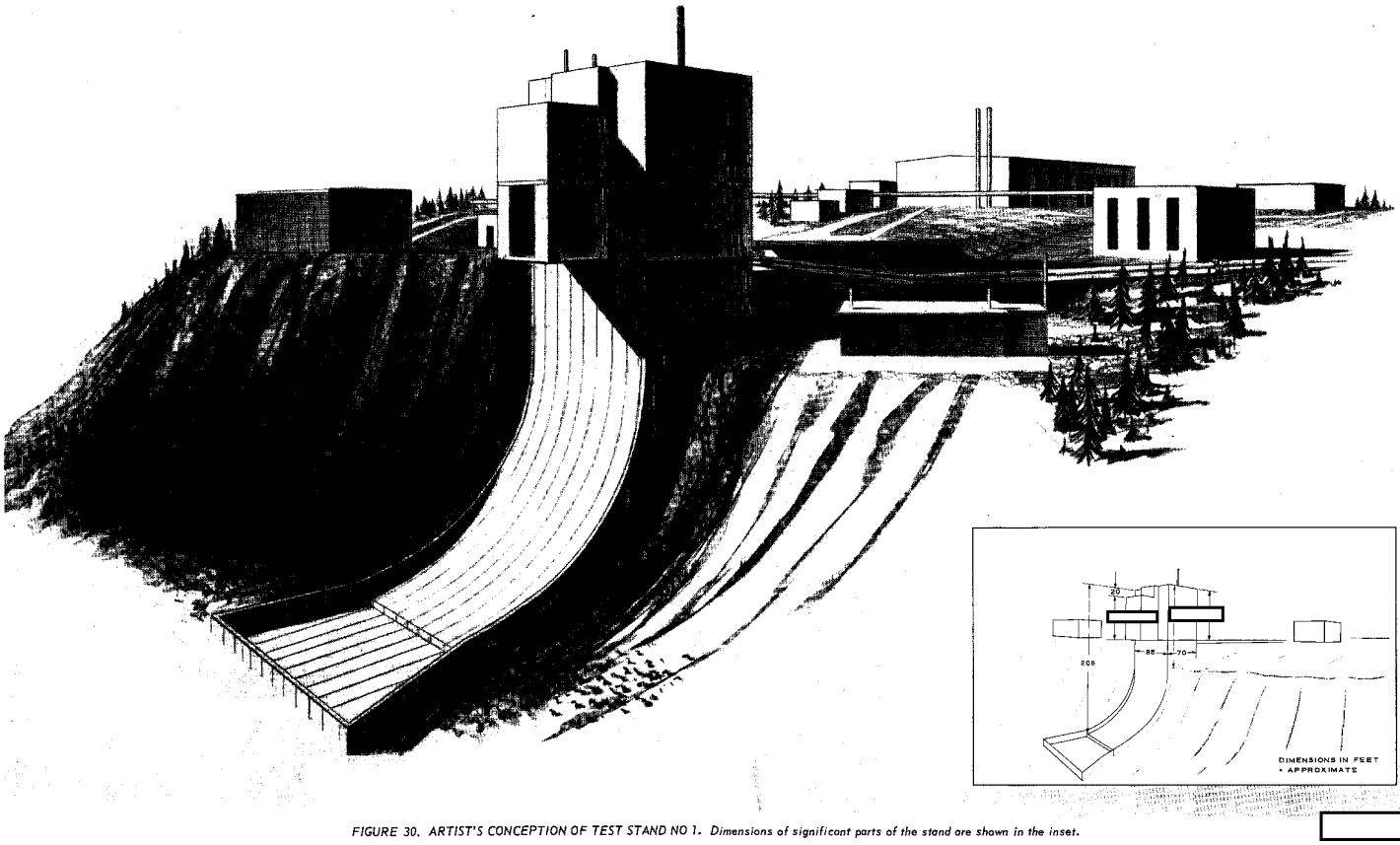


FIGURE 30. ARTIST'S CONCEPTION OF TEST STAND NO 1. Dimensions of significant parts of the stand are shown in the inset.

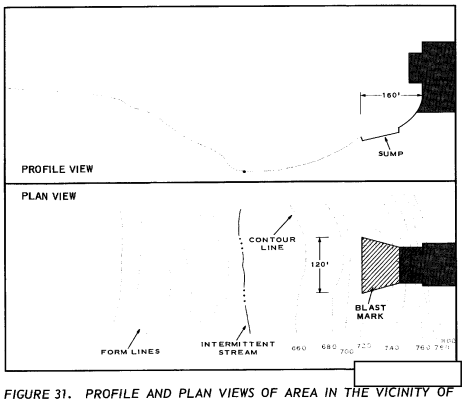


FIGURE 31. PROFILE AND PLAN VIEWS OF AREA IN THE VICINITY OF TEST STAND NO 1. These views show the extent of blast marks.

pipeline probably supplies propellant to a small probable propellants storage building (item 8) which is near the stand. A large semiburied tank near the stand may provide the necessary volume of water for cooling the blast delfector. A rail spur, probably narrow gauge, extends from the larger of the assembly/checkout buildings (item 5) to the test stand. An object resembling the possible missile component observed at the Kurumoch Rocket Engine Test Facility was observed on this track on photography of

TEST STAND NO 2

Test Stand No 2 (item 2, Figure 29) was not present on photography of Photography revealed very early signs of preliminary grading at the site, and photography revealed the beginnings of an excavation for the blast pit and flame deflector. Continuing construction was evident on photography obtained during the stand was nearing completion, but was possibly still incomplete in Photography of revealed the stand to be complete. No evidence of testing has been observed.

A photograph of Test Stand No 2 (which includes a good view of Test Stand No 1) is presented in Figure 32; dimensions of Test Stand No 2 are given in the inset. Two probable diffusers which protrude below the overhanging portion of the test stand indicate that this stand probably contains 2 test positions. The probable diffusers are clearly visible in Figure 32; the larger probable diffuser is estimated to be 20 feet long. A construction crane is positioned on the embankment near the larger probable diffuser. The taller rear section of the stand rises feet above grade. The rear section measures feet; a large pipeline enters the section 50 feet below the top. The overhanging portion of the stand measures . The blast pit and flame deflector slope downward for at least 50 feet to their deepest point, which is 45 feet wide, and then rise approximately (a slope distance of approximately where the flame deflector narrows to approximately

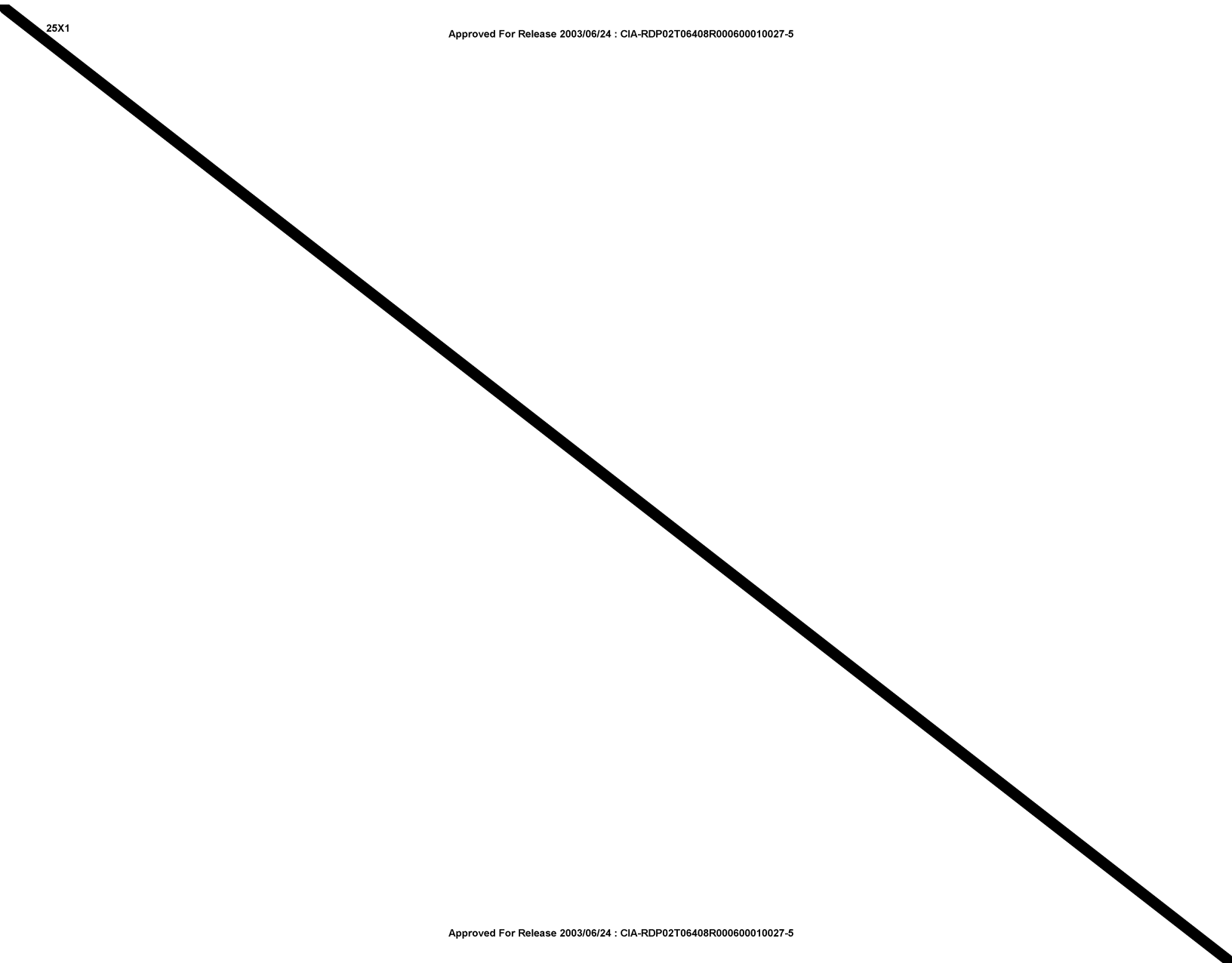
A probable control building (item 3, Figure 29) is situated on an embankment south-southeast of the stand and is connected to the stand by pipelines. Three other small structures and a semiburied tank are nearby.

Test Stand No 2 is probably designed for test firing smaller rocket engines and/or engine components and may have altitude simulation capabilities. It does not closely resemble any other known Soviet test stands.

ILLEG [redacted] 25X1

25X1 FIGURE 32. TEST STANDS NO 1 AND NO 2, [redacted] Dimensions of significant parts of Test Stand No 2 are shown in the inset.

25X1



PERM ROCKET TEST FACILITY

The Perm Rocket Engine Test Facility is located at 58-01N 056-34E, 7.5 nm east of Perm, USSR (Figure 33). The facility was apparently in the late stages of construction as originally laid out when it was first observed in The large test stand, Test Stand No 1, was probably operational in late 1963 or early 1964, although evidence of test activity was not observed until . The facility was enlarged, beginning in early 1964. Test Stand No 2 was first observed while under construction in and was outwardly complete in No test activity has been identified at this stand to date.

Figure 34 is an oblique photograph of the Perm facility. The layout and topography of the facility are shown in Figure 35. There are indications that the facility was completed in and was subsequently enlarged for an expanded or more complex test program. An air liquefaction plant (item 16, Figure 35 and Table 7), its associated probable cryogenic storage tanks (items 17 and 18), and the probable 2-fan cooling tower (item 15) were constructed between A large high-bay possible fabrication building (item 11) was also started in and was in the final stages of construction in A separately secured fuel storage area is located in the northernmost corner of the facility and a water treatment area is located on the southeast side. An electric power substation is situated at the easternmost corner.

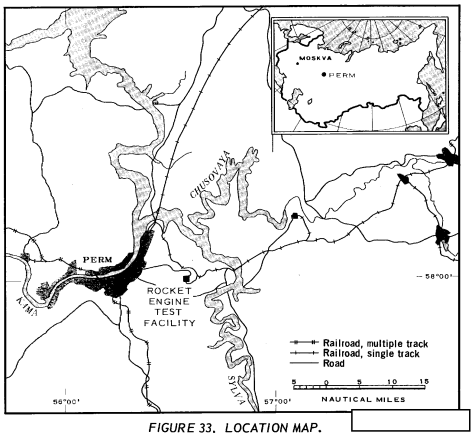


FIGURE 33. LOCATION MAP.

TEST STAND NO 1

Test Stand No 1 (item 24) was first observed in and was apparently in the later stages of construction at that time. the stand was probably still incomplete, but it was outwardly complete by Photography of revealed, on the slope around the blast deflector, a slight tone difference that might be an indication of possible test activity; however, the poor quality of the photography does not permit a positive identification. Although photography revealed dark stains--indicative of test activity--in the sump and on the blast deflector, no large deposits of exhaust particles were visible on the surrounding slopes. a large pipeline was extended to the test stand from a probable pumphouse (item 19) near the air liquefaction plant (item 16). Dark stains were again observed in the sump on photography of and faint suspect blast scarring was visible on the opposite slope (Figure 37).

Test Stand No 1 is very similar to test stands at Kurumoch and Krasnoyarsk. An artist's conception of the test stand is presented in Figure 36, and dimensions of significant parts of the stand are shown in the inset. The article to be tested is suspended in the projection which measures 35 by 30 feet and approximately 60 feet high; the projection overhangs the blast defector and partially covers the width of the test stand. This stand appears to be a single-position stand for testing liquid propellant rocket engines. An access ramp spans the distance from the edge of the embankment to the stand and enters the rear center of the stand at a level approximately 80 feet below the top of the stand and probably on a level with the bottom of the partial width overhanging projection.

The main structure of the test stand measures 85 by 70 feet and rises approximately 150 feet above grade at the front and a total of approximately 195 feet above the sump. The control building for Test Stand No 1 (item 23, Figure 35) is situated on a cliff northeast of the stand and is connected to the stand by a cable tray/walkway. A large assembly/checkout building with 2 low roof monitors (item 22) and the smaller hip-roofed assembly and checkout building (item 21) are situated approximately 800 feet southeast of the stand.

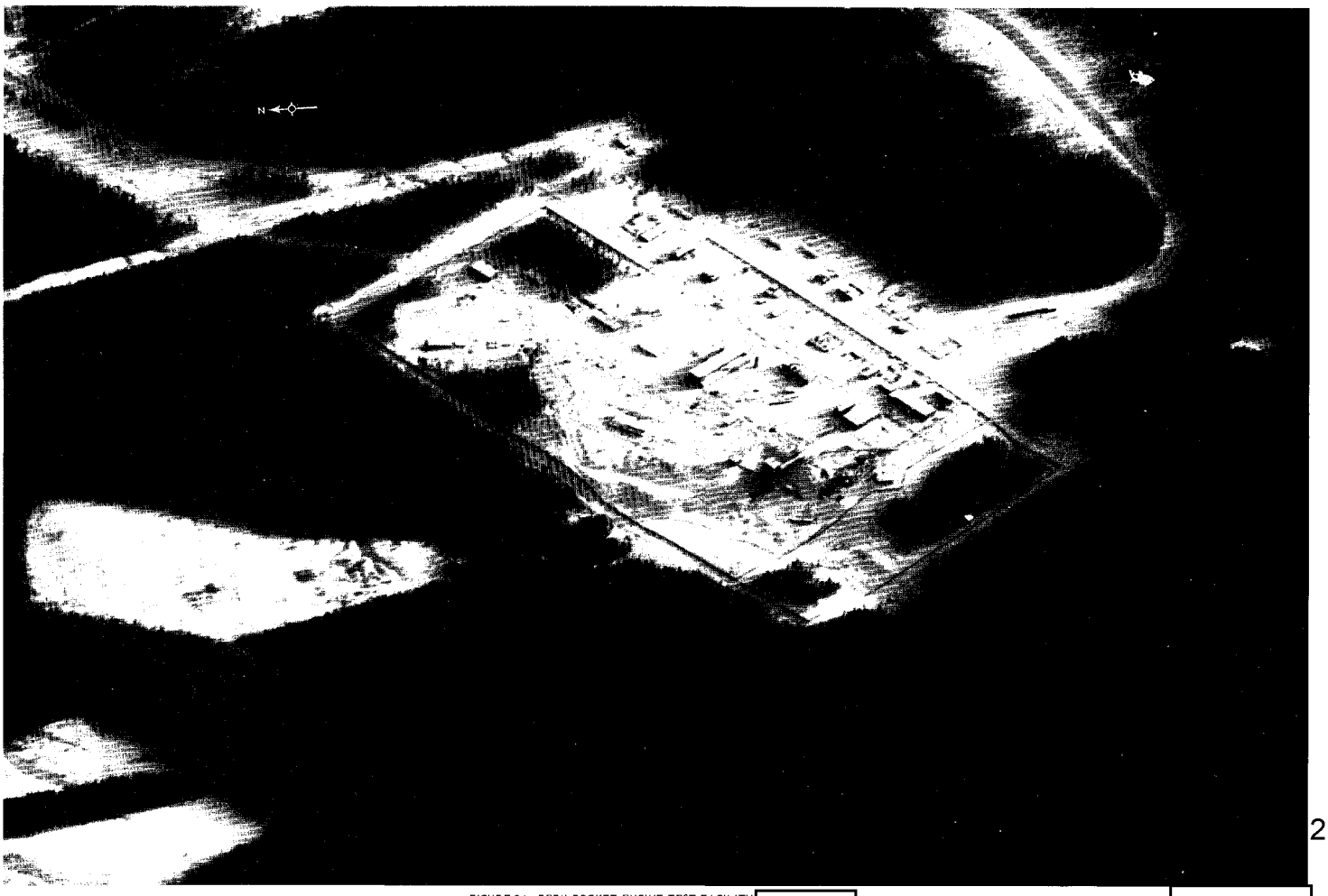
TEST STAND NO 2

Test Stand No 2 (item 25) is located in the western part of the Perm Rocket Engine Test Facility in an area expanded specifically to encompass it. Although ground traces and indications of activity were evident in this area as early as excavations for the test stand and the control building (item 26) for Test Stand No 2 were not evident until and construction continued through a pipeline

Table 7. Description/Function, Dimensions, and Roof Cover of Structures at Perm Rocket Engine Test Facility (Item numbers appear in Figure 35)

Item No	Description/Function	Dimensions* (ft) Length	Width	Height	Roof Cover (sq ft)
1	Vehicle shed	220**	65	20	14,300
2	Admin bldg	165	30	--	4,950
3	Admin bldg	85	55	25	4,375
4	Maintenance bldg	120	65	30	7,800
5	Service bldg			--	11,040
6	Prob storage bldg	135**	40**	--	5,400
7	Shipping & receiving bldg	150**	40**	--	6,000
8	Prob shop/fabrication bldg	150**	40**	--	6,000
9	Poss receiving bldg	130	40	10	5,200
10	Prob storage bldg	135	60	20	8,100
11	Large high-bay poss fabrication bldg	440	190**	55**	83,600
12	Steamplant	250**	100**	--	25,000
13	Rail-served receiving bldg	115	30	35	3,450
14	Small support bldg	100	65	20	6,500
15	Prob 2-fan cooling tower	50**	25**	--	1,250
16	Air liquefaction plant	295	70	50	20,650
17	Prob cryogenic storage tank		35**(diam)	--	--
18	Prob cryogenic storage tank		35**(diam)	--	--
19	Prob pumphouse	70	40	--	2,800
20	Rail-served support bldg	215	110	35	23,650
21	Hip-roofed assembly/ checkout bldg	140	45	--	6,300
22	Large assembly/checkout bldg with low roof monitors	190	120	45	22,800
23	Control bldg for Test Stand No 1	50	50	--	2,500
24	Test Stand No 1	105	85	80**	7,000
25	Test Stand No 2	60**	60**	75**	2,500
26	Control bldg for Test Stand No 2	95**	45**	--	4,275

*All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.
**Approximate.



25X1

FIGURE 34. PERM ROCKET ENGINE TEST FACILITY [redacted]

25X1

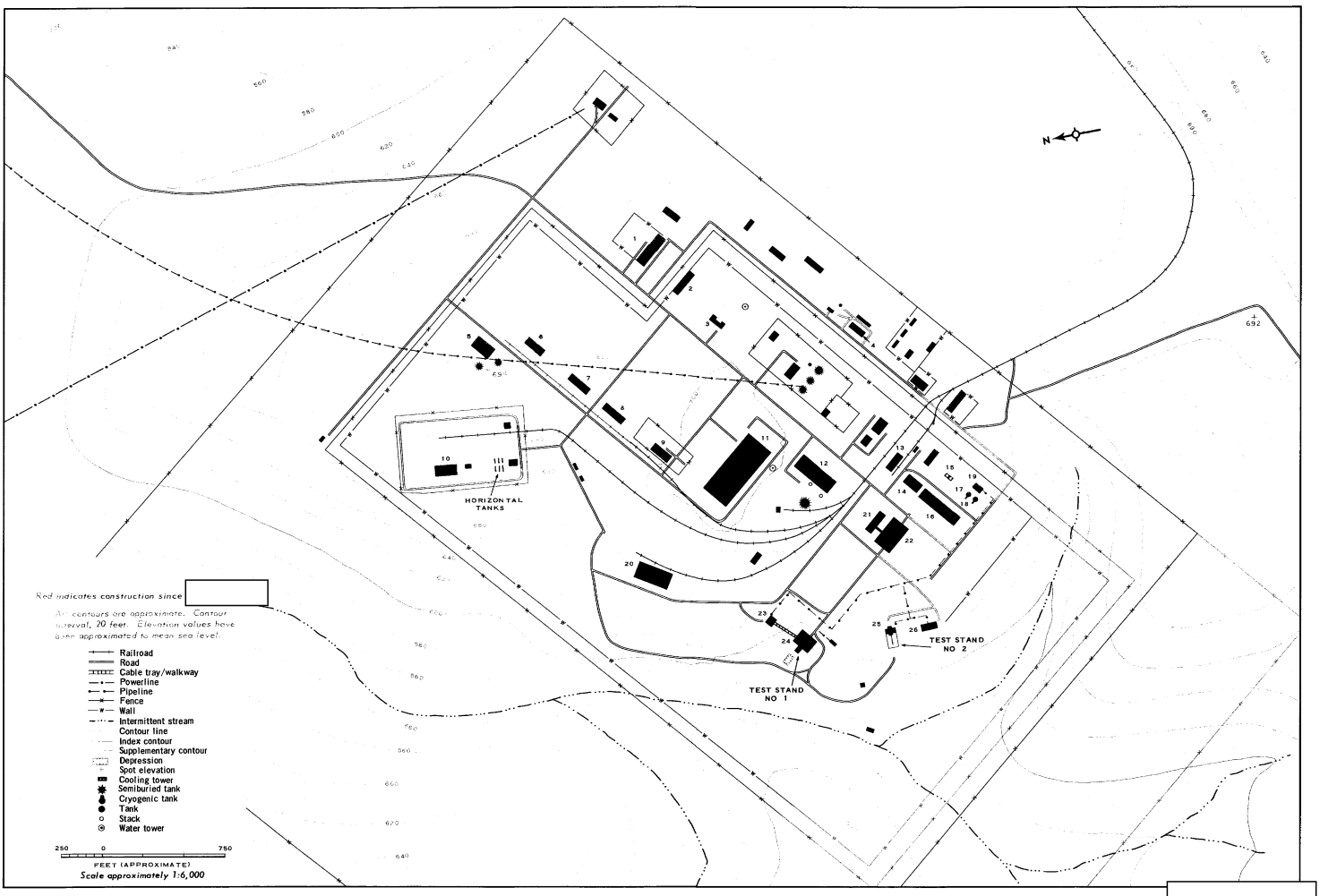


FIGURE 35. LAYOUT AND TOPOGRAPHY OF PERM ROCKET ENGINE TEST FACILITY.

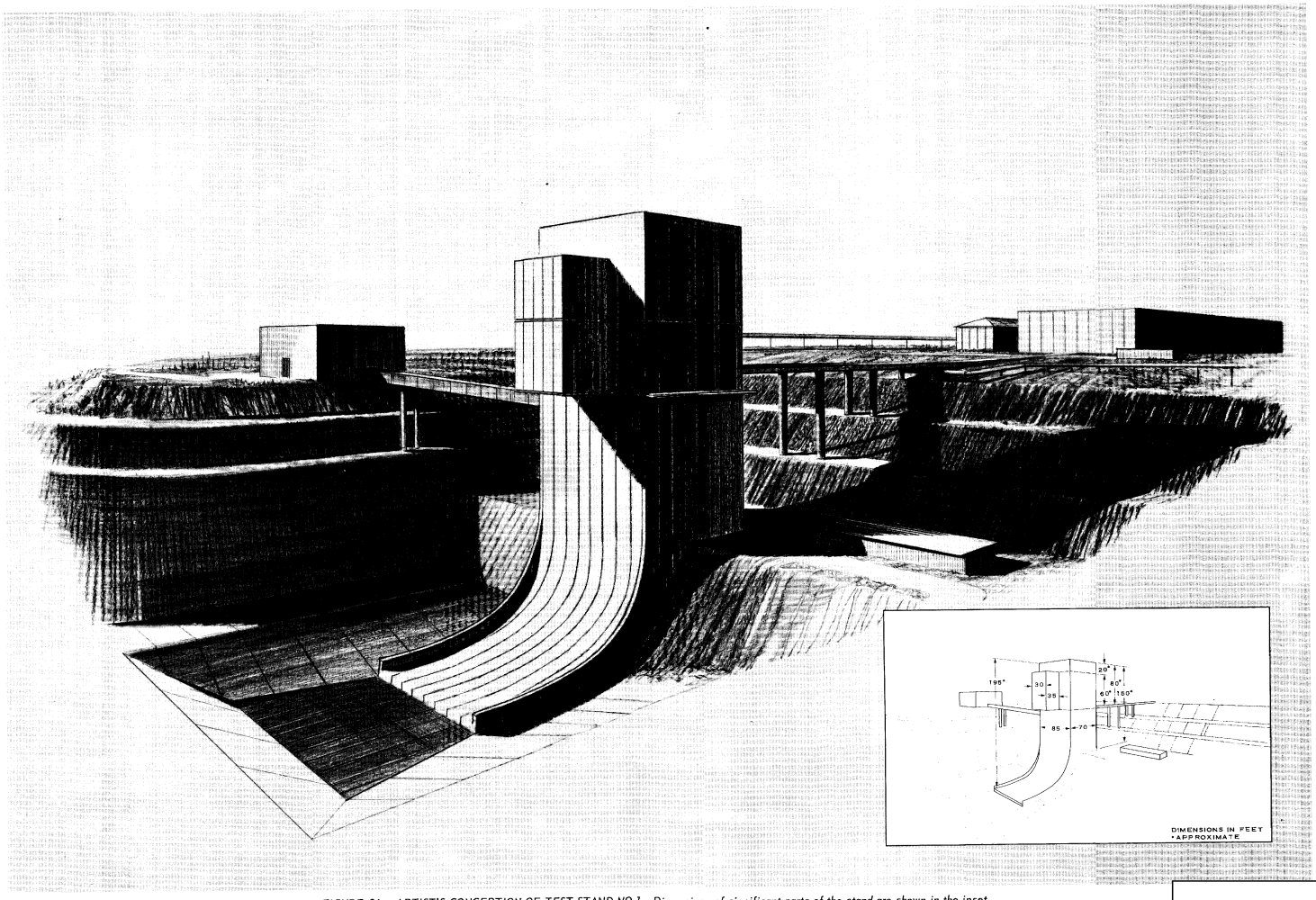


FIGURE 36. ARTIST'S CONCEPTION OF TEST STAND NO 1. Dimensions of significant parts of the stand are shown in the inset.

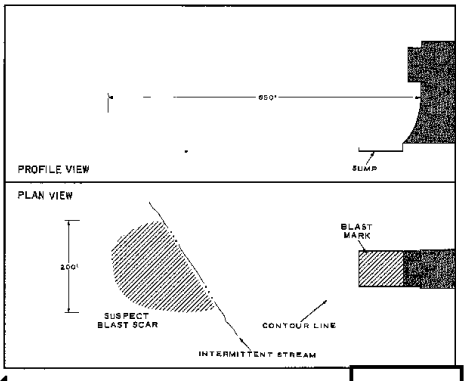


FIGURE 37. PROFILE AND PLAN VIEWS OF AREA IN THE VICINITY OF TEST STAND NO 1. These views show the extent of blast marks.

was extended to Test Stand No 2 from a pipeline that serves Test Stand No 1 (item 24). On [redacted] photography, the test stand appeared to be outwardly complete and closely resembled Test Stand No 2 at the Voronezh Rocket Engine Test Facility. No test activity has been identified at Test Stand No 2.

Although the quality of the photography does not permit exact measurements, approximate dimensions of Test Stand No 2 are 60 by 60 feet overall with a slightly raised and extended center section and a long, tubular, downward-slanting diffuser/vacuum aspirator extending from the front. This stand appears to have a single test position designed for testing relatively small engines and/or components, and it probably has altitude simulation capabilities. A recent view of the facility is presented in Figure 38; the appearance of Test Stand No 2 after completion is also shown in this figure.

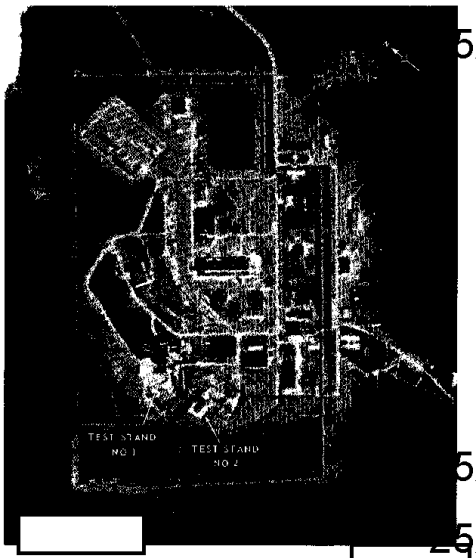
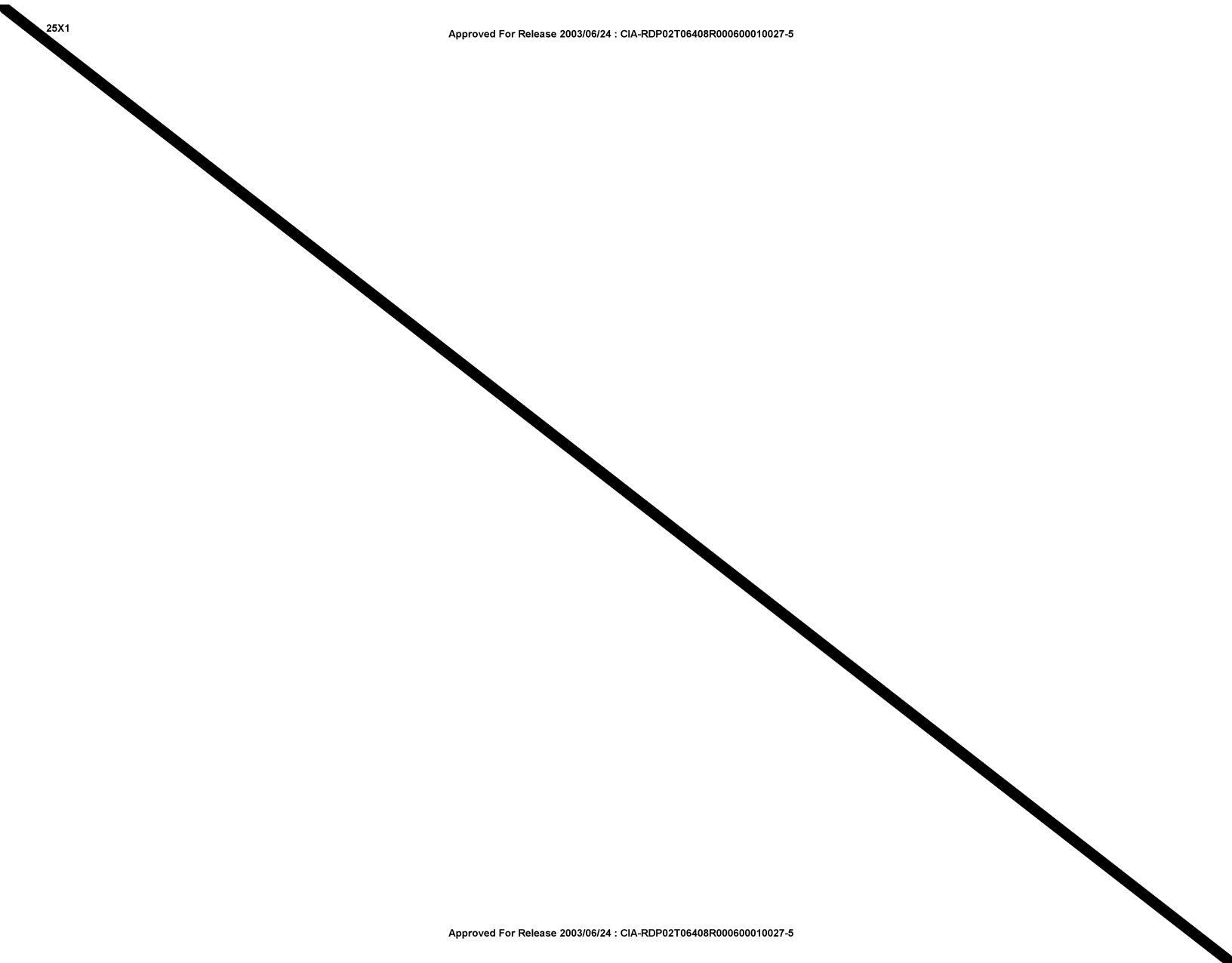


FIGURE 38. PERM ROCKET ENGINE TEST FACILITY,



VORONEZH ROCKET ENGINE TEST FACILITY

The Voronezh Rocket Engine Test Facility (BE No [redacted]) is located at 51-35N 039-10E, 5 nm south of Voronezh (Figure 39). The facility, not present on World War II photography of 1943, was first observed on [redacted] photography of [redacted] when it consisted of a secured area containing a single test building which probably contained 6 test cells; 2 probable horizontal test positions were located nearby. The facility appeared operational at that time, and construction activity was apparent outside the secured area. [redacted] photography of [redacted] revealed that the facility had been enlarged considerably: a second test cell building was apparently under construction and an excavation was visible at the future site of Test Stand No 1. This stand, first test fired during [redacted] is a large vertical stand. A second test stand, which has a protruding diffuser/vacuum aspirator, was constructed between [redacted] No test activity has been identified at this stand as of [redacted] A photograph of the test facility is presented in Figure 40.

The layout of the facility and the topography of the area are shown in Figure 41. A separately secured area contains an air liquefaction plant (item 15, Figure 41 and Table 8), an adjacent storage tank of unusual configuration, 3 probable cryogenic tanks (items 16, 17, and 18), a cooling tower (item 19), several small tanks, and other support buildings including a rail-served possible storage building (item 14). Wells, water-treatment and storage facilities, an electric power substation, and an oil-fired steamplant (item 10) with adjacent oil storage supply basic utilities. The 3 rail-served possible propellant storage and handling buildings (items 2 and 6) are located near the center of the facility. The single large assembly/checkout building (item 24) associated with Test Stand No 1 appears to be composed of 2 adjacent assembly/checkout buildings of the type observed at Kurumoch, Krasnoyarsk, Perm, and Omsk.

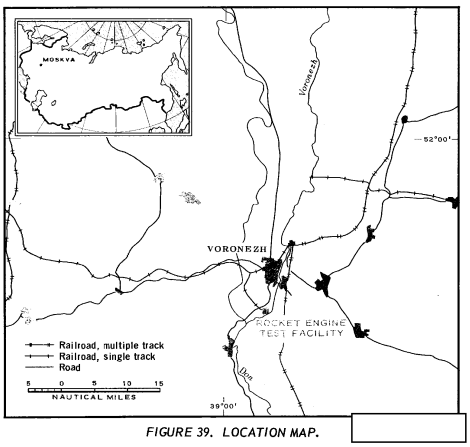


FIGURE 39. LOCATION MAP. [redacted]

TEST STAND NO 1

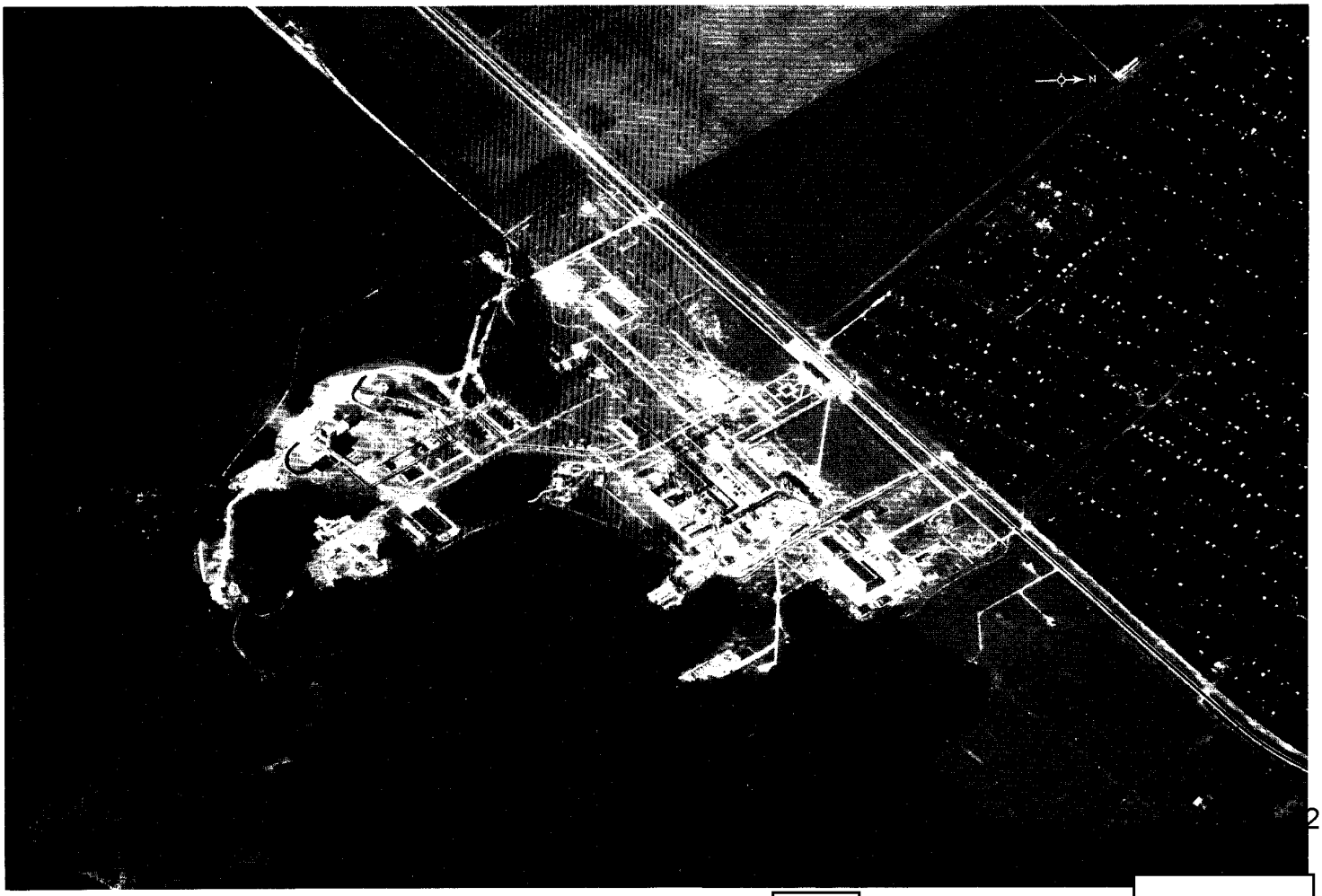
Test Stand No 1 (item 22) was first observed under construction in [redacted] when an excavation at its site and a clearing at the future site of the associated assembly/checkout building (item 24) were seen. By [redacted] the assembly/checkout building had been constructed, and construction work evidently was continued on Test Stand No 1. When observed again in [redacted] a rail spur which would serve the facility was first seen to be under construction. [redacted] photography, although of poor quality, revealed the superstructure of the test stand for the first time and also clearly revealed the control building (item 21) for the first time. The test stand was probably incomplete at this time. On [redacted] photography the test stand was outwardly complete; a control building, an assembly/checkout building, and pipelines emanating from a nearby pumphouse (item 23) were also observed. [redacted] photography revealed more details of the stand. No definite test activity was identified, although the sump was somewhat discolored. Photography of [redacted] over the snow-covered facility revealed no definite blast marks at the stand; however, [redacted] photography, also obtained when the facility was snow covered, clearly revealed a blast mark which had blackened the hillside opposite the test stand and consisted of melted snow and/or deposited exhaust particles. Photography of [redacted] also revealed a blast mark. This blast mark consisted of burned vegetation extending approximately 500 feet beyond the front of the test stand and measuring approximately 200 feet across at its widest point. This blast mark had the same shape of the blast mark which appeared on the [redacted] coverage. No blast mark was visible on photography of [redacted] when the facility was again snow covered. [redacted] coverage again revealed the burned vegetation, which appeared to cover a slightly larger area (approximately 600 feet long) than that seen in [redacted] Profile and plan views of the test stand and its surrounding terrain which show the pattern of the blast marks are presented in Figure 43.

Test Stand No 1 is very similar to the test stands at the Kurumoch and Omsk Rocket Engine Test Facilities. An artist's conception and the dimensions of this stand are presented in Figure 42. The flame deflector is probably water cooled. The article to be tested is probably suspended in the approximately [redacted] overhanging projection, which extends across the full width of the stand and probably contains a single test position. An object, resembling an enclosure for a rollup door or possibly a

Table 8. Description/Function, Dimensions, and Roof Cover of Structures at Voronezh Rocket Engine Test Facility (Item numbers appear in Figure 41)

Item No	Description/Function	Dimensions[a] (ft) Length	Width	Height	Roof Cover (sq ft)
1	Receiving bldg				
2	Poss propellant storage and handling bldg (2)				
3	Poss laboratory/admin bldg				
4	Receiving & admin bldg				
5	Admin bldg				
6	Poss propellant storage & handling bldg				
7	Poss cold-flow bldg				
8	Pumphouse				
9	Warehouse				
10	Steamplant				
11	Pumphouse				
12	Original test cell bldg				
13	Test cell bldg				
14	Rail-served poss storage bldg				
15	Air liquefaction plant				
16	Prob cryogenic storage tank				
17	Prob cryogenic storage tank				
18	Prob cryogenic storage tank				
19	Cooling tower				
20	Test Stand No 2 (horizontal)				
21	Control bldg				
22	Test Stand No 1 (vertical)				
23	Pumphouse				
24	Assembly/checkout bldg				

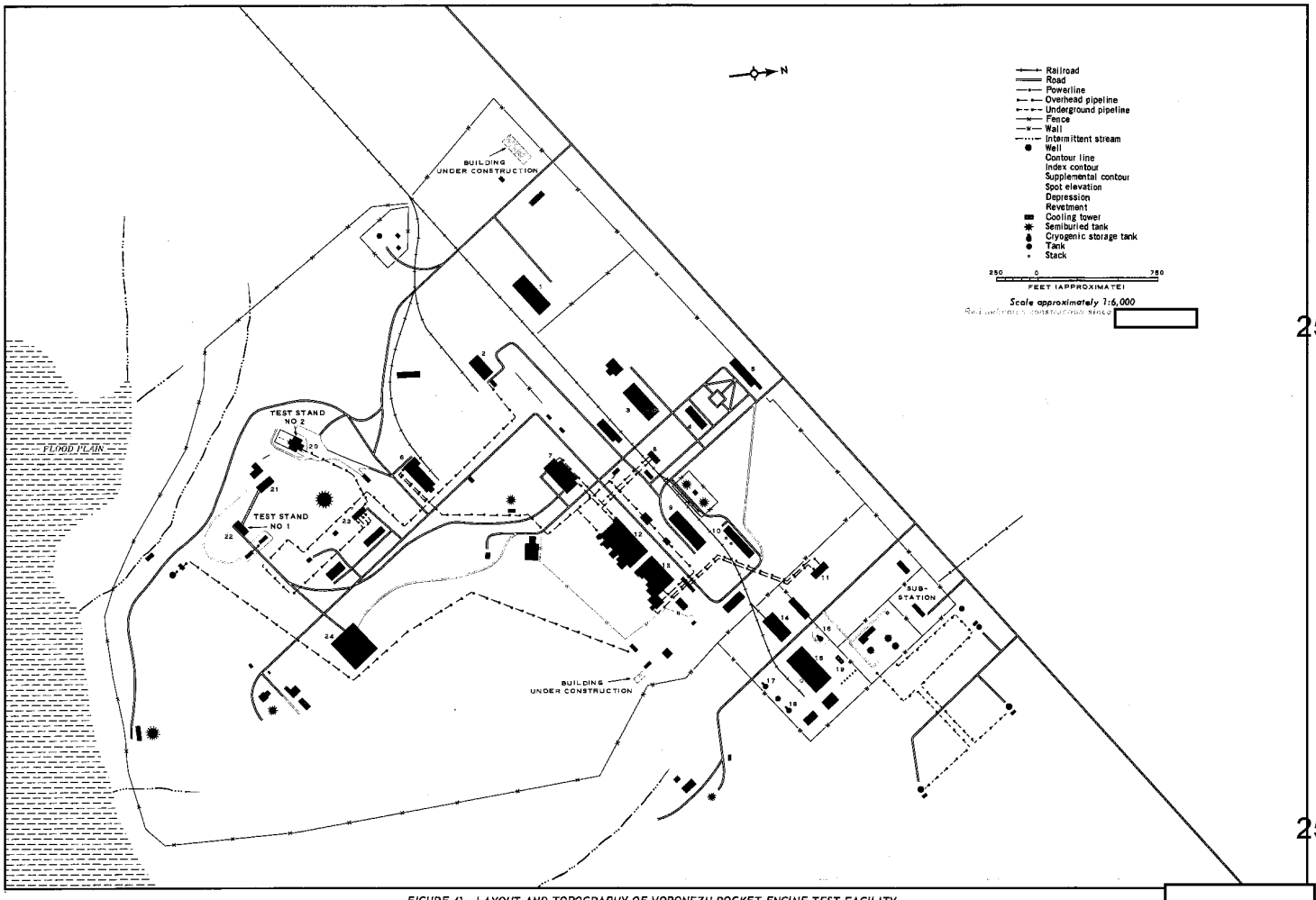
[a] All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.



25X1

FIGURE 40. VORONEZH ROCKET ENGINE TEST FACILITY

25X1



25X1

25X1

FIGURE 41. LAYOUT AND TOPOGRAPHY OF VORONEZH ROCKET ENGINE TEST FACILITY.

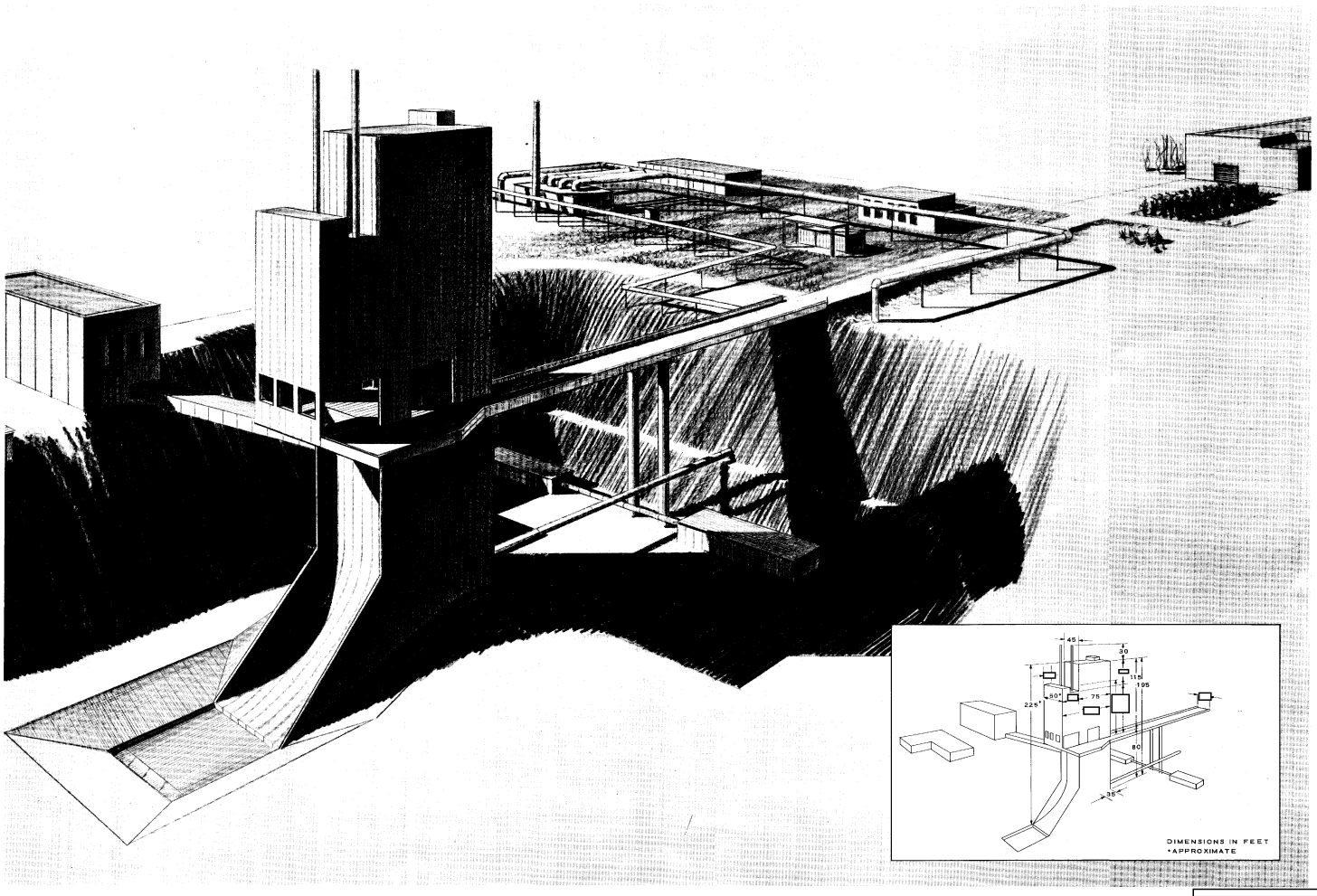


FIGURE 42. ARTIST'S CONCEPTION OF TEST STAND NO 1. Dimensions of significant parts of the stand are shown in the inset.

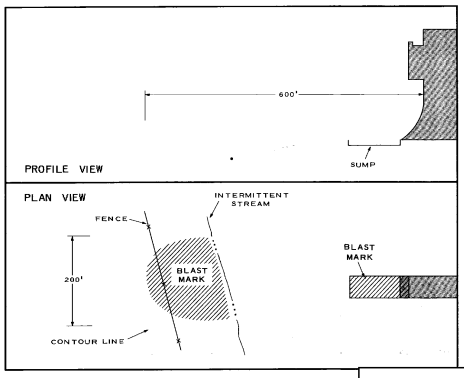


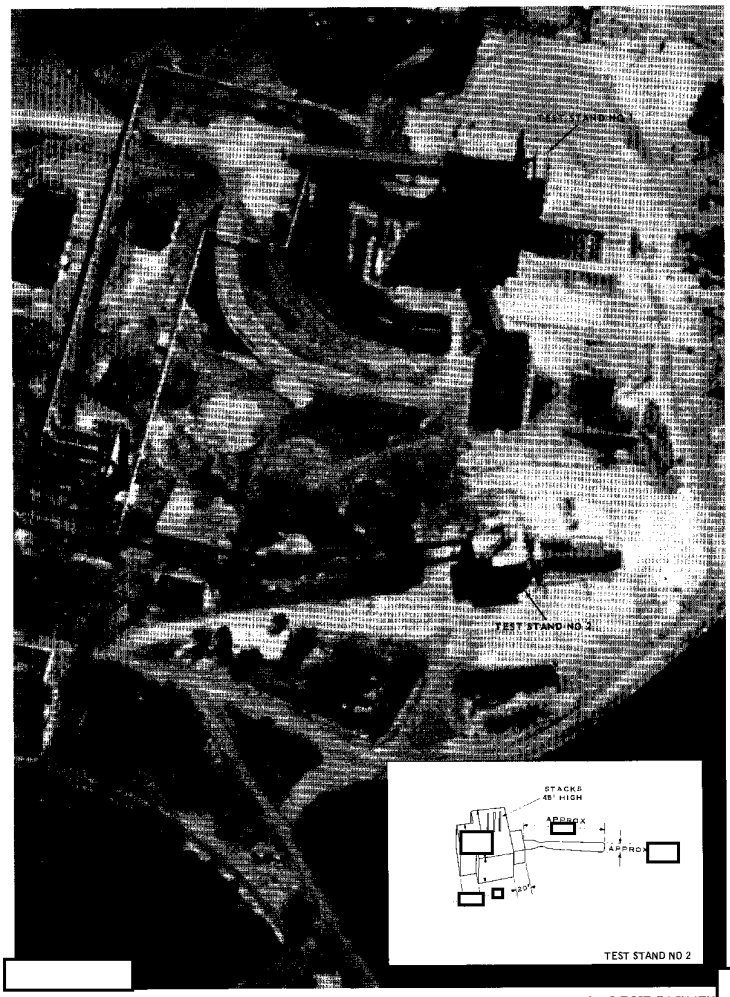
FIGURE 43. PROFILE AND PLAN VIEWS OF TEST STAND NO 1. These views show the extent of blast marks.

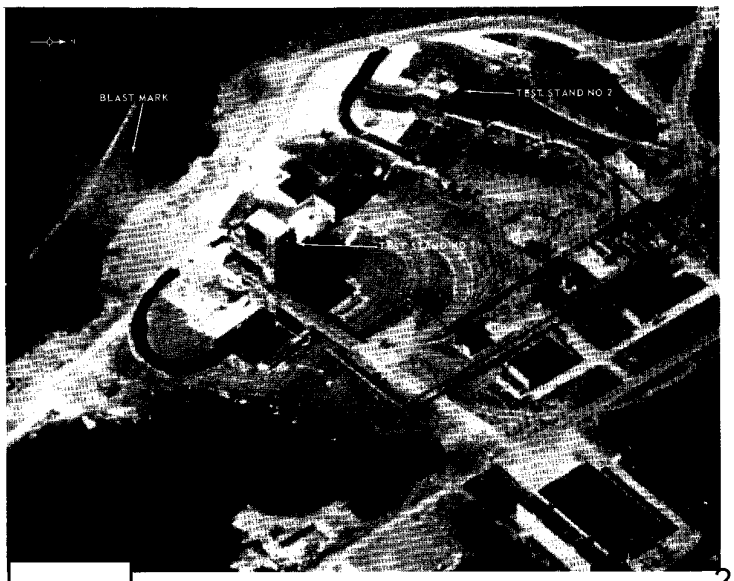
horizontal tank and measuring [redacted] rests on top of the projection. An access ramp enters the side of the stand 115 feet below the top of the stand and apparently on a level with the bottom of the projection. The highest part of the superstructure of the stand is 75 by 45 feet and rises 195 feet above grade at the rear of the stand and approximately 225 feet above the blast pit or sump. The assembly/checkout facility (item 24, Figure 41) is situated approximately 900 feet northeast of the stand, and a rectangular control building (item 21) is approximately 250 feet northwest of the stand. This building is connected to the stand by a [redacted] cable tray/walkway. A curved probable roadway (which may be a narrow-gauge rail line) extends from a possible cold-flow building (item 7) to the stand.

TEST STAND NO 2

Test Stand No 2 (item 20) is located 600 feet northwest of Test Stand No 1 and utilizes the same control building (item 21) that serves Test Stand No 1. Test Stand No 2 was not present when the facility was observed on photography of [redacted] Photography of [redacted] revealed construction activity at the site of the future test stand; but it was not until [redacted] that details of the test stand, apparently in mid-stages of construction, were revealed. A buried conduit was visible leading to the nearby control building (item 21) and the configuration of the stand gave an indication that the article to be tested would be fired horizontally. Photography of [redacted] showed that the stand was in the final stages of construction and a long diffuser/vacuum aspirator was observed to protrude from the front of the stand. [redacted] photography (Figure 44) revealed that the stand is outwardly complete and that it is a T-shaped structure [redacted] overall with a 20-foot-thick segment adjoining a diffuser/vacuum aspirator approximately [redacted] in diameter. The aspirator slopes downward slightly and has a narrowed section near the test stand. The stand rises 75 feet above grade with three 45-foot stacks on top. This stand closely resembles Test Stand No 2 at the Perm Rocket Engine Test Facility.

Photography of [redacted] (not shown) and [redacted] (Figure 44) shows that additional landscaping has been completed. However, no positive indications of test activity were observed. This stand apparently contains a single-test position designed for testing relatively small engines and/or components and probably has an altitude simulation capability.





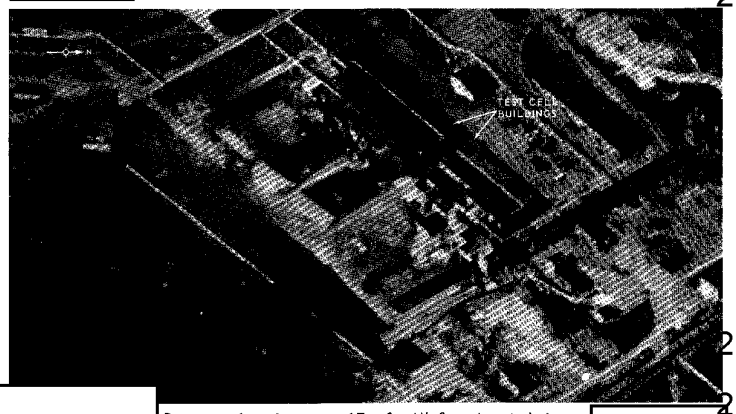
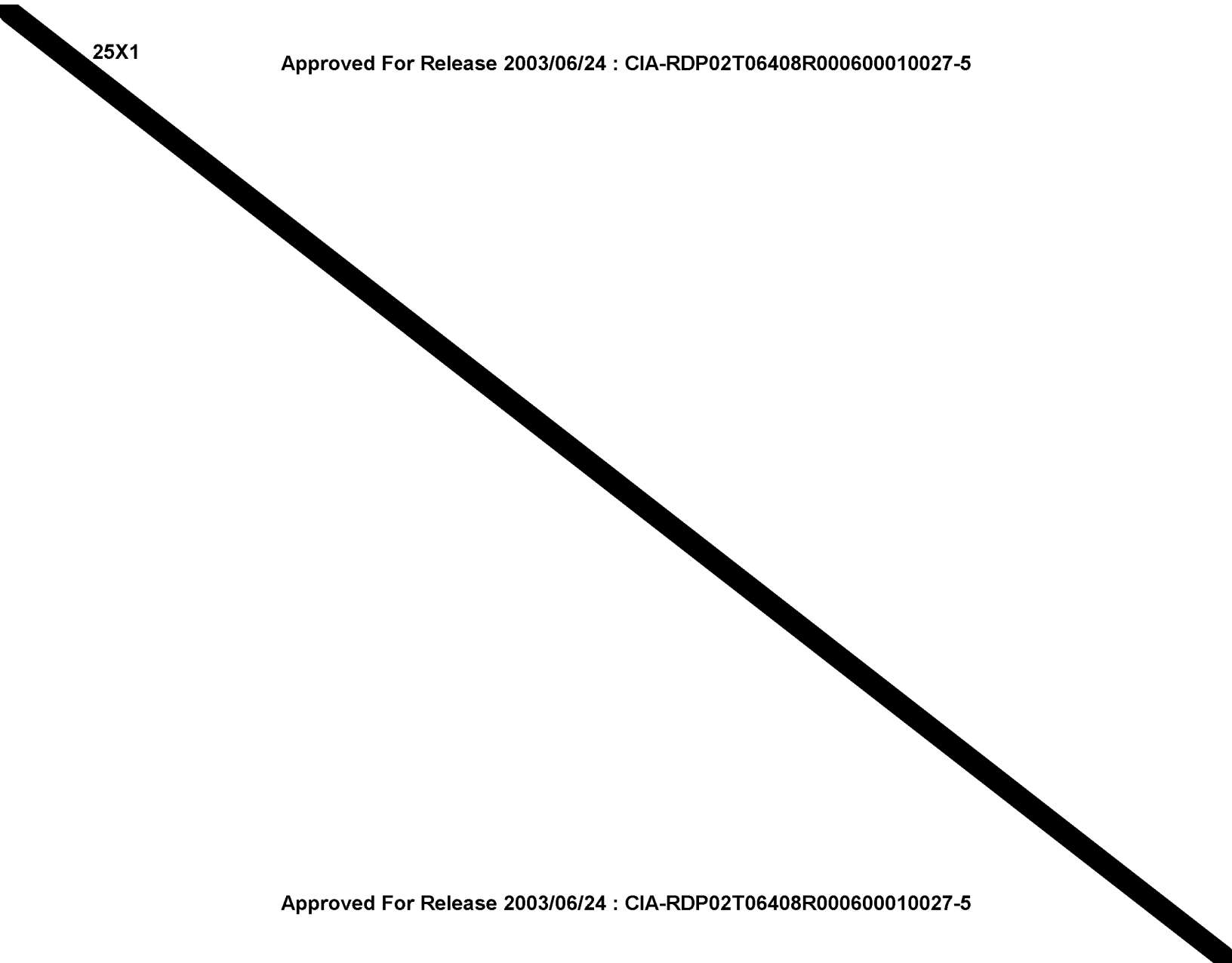


FIGURE 44. VIEWS OF TEST STRUCTURES AT VORONEZH ROCKET ENGINE TEST FACILITY. *Dimensions of significant parts of Test Stand No 2 are shown in the inset.*



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OMSK ROCKET ENGINE TEST FACILITY

The Omsk Rocket Engine Test Facility is located at 55-25N 73-17E, approximately 28 nm north of Omsk, USSR (Figure 45). The site is double secured and has guard towers at the corners. The facility was first observed in when it was under construction; an excavation for the flame deflector for Test Stand No 1 was visible. The facility was probably operational by mid-1963. In however, construction was started on a second test stand (Test Stand No 2) which has shown no evidence of test activity as of

Figure 46 is a photograph of the Omsk Rocket Engine Test Facility. The layout and topography of the facility are shown in Figure 47. The air liquefaction plant (item 15, Figure 47 and Table 9), its associated probable cryogenic storage tanks (items 16 and 17), and probable cooling tower (item 18) are situated near the center of the facility close to a large possible pump/compressor building (item 8) that is very similar to a building at the Kurumoch Rocket Engine Test Facility (Table 12). A large possible fuels processing/fabrication building (item 7) is similar to a building at the Krasnoyarsk Rocket Engine Test Facility. Several other buildings are also very similar to buildings observed at other Soviet rocket engine test facilities. Details of the construction chronology of each structure in the facility are given in a recently published report. 1/ It is anticipated that this type of detailed report will be prepared for each of the liquid propellant rocket engine test facilities in the USSR.

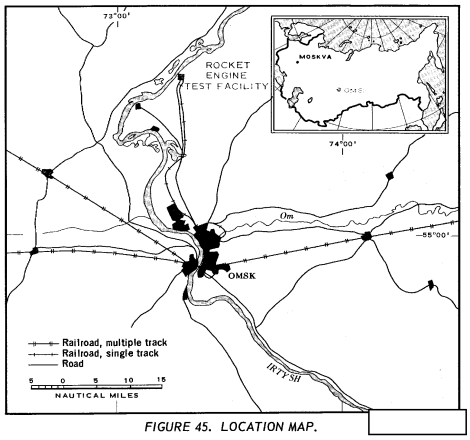


FIGURE 45. LOCATION MAP.

TEST STAND NO 1

Test Stand No 1 (item 1) was first indicated by the presence of an excavation for its flame deflector and blast pit in and the structure of the stand was observed to be under construction in The stand was incomplete in and probably outwardly complete in No evidence of a test firing was observed in In a possible blast mark was observed, indicating that the stand was probably complete and operational. Subsequently, blast marks have been observed a total of 14 times even though after initial firings had taken place, it was not possible to distinguish readily between the residual effects of previous firings and the marks of recent firings on nonsnow-covered terrain, except when these marks were measurably larger. 1/ Some of the most striking examples of the blast marks were obtained when the facility was snow covered during Burn marks were visible on photography of A profile of the topography of Test Stand No 1 (Figure 49) shows the extent of the most recent burn mark which measures approximately 650 by 250 feet. Some faint stains or deposits which extended approximately 1,100 feet from the flame deflector were observed on photography of this was undoubtedly caused by the wind and the flatness of the terrain.

Test Stand No 1 is quite similar to the liquid propellant rocket engine test stands at Kurumoch and Voronezh. Figure 48 is an artist's conception of the test stand; the inset shows dimensions of the test stand. The article to be tested is placed in a tall projection that extends across the full width of the test stand and probably contains a single test position. An access ramp enters the side of the stand at a level feet below the top of the stand and on a level with the bottom of the front projection. The highest part of the superstructure of the stand is above grade at the rear and a total of approximately above the blast pit or sump. Assembly/checkout buildings (items 9 and 10) are situated approximately 600 feet southwest of the stand, and a control and instrumentation building (item 2) is located on a bank approximately 200 feet east of the stand; the control and instrumentation building is connected to the stand by a cable tray/walkway.

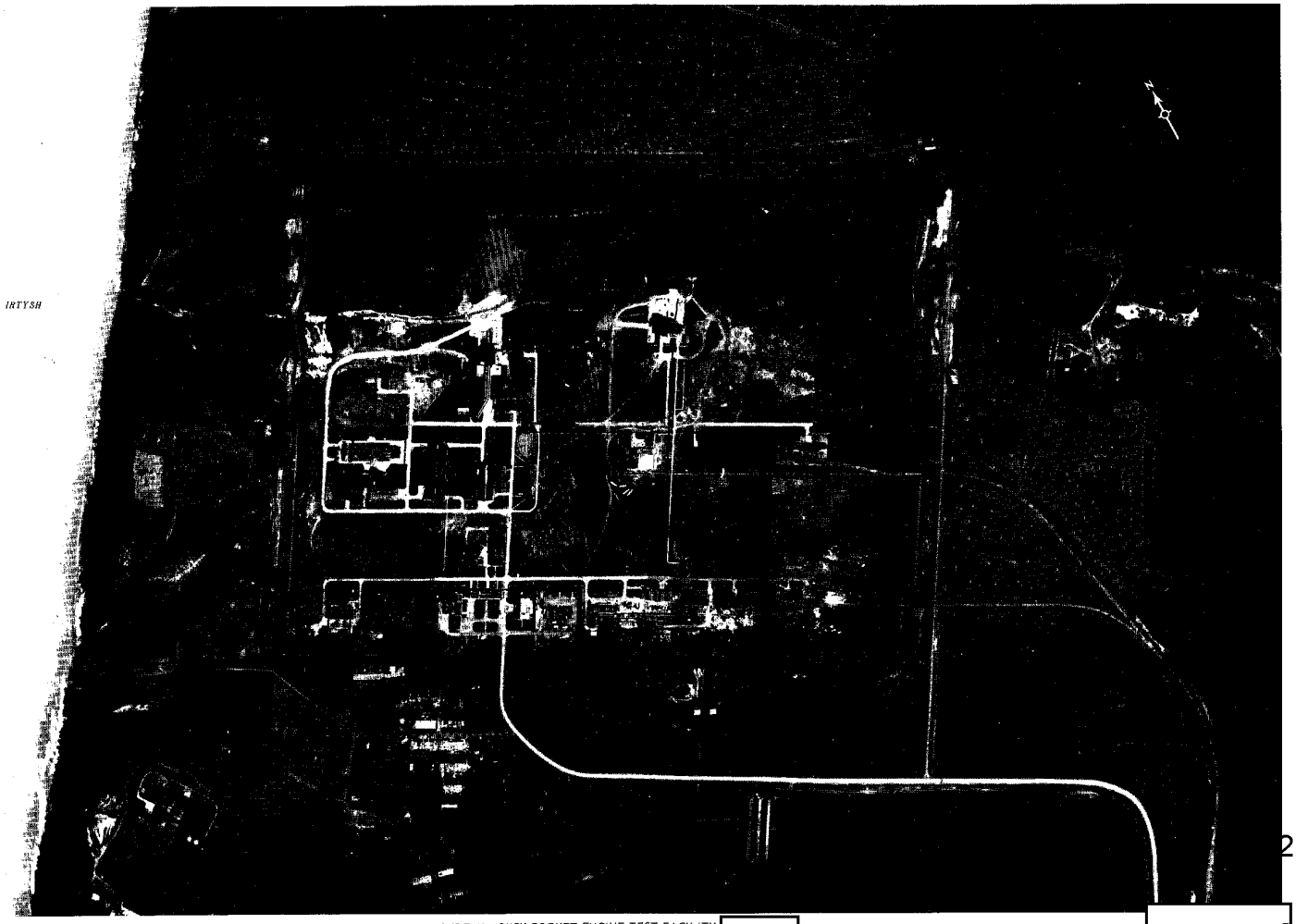
TEST STAND NO 2

Test Stand No 2 (item 3) was not present on photography of Photography of revealed an excavation at its future site. By a building was apparent at the site of this excavation, and construction has continued steadily since that time. Two access ramps were under construction in and completed in

Table 9. Description/Function, Dimensions, and Roof Cover of Structures at Omsk Rocket Engine Test Facility (Item numbers appear in Figure 47)

Item No	Description/Function	Dimensions[a] (ft) Length	Width	Height	Roof Cover (sq ft)
1	Test Stand No 1				
2	Control & instrumentation bldg				
3	Test Stand No 2				
4	Control & instrumentation bldg				
5	U/I bldg				
6	10 vertical tanks & 1 bldg				
7	Poss fuels processing/ fabrication bldg				
8	Poss pump/compressor bldg				
9	Assembly/checkout bldg				
10	Assembly/checkout bldg				
11	Poss components assembly/ test bldg				
12	Poss propellant receiving bldg				
13	Shipping/receiving bldg				
14	Prob shop/fabrication bldg				
15	Air liquefaction plant				
16	Prob cryogenic storage tank				
17	Prob cryogenic storage tank				
18	Prob cooling tower				
19	Prob pumphouse				
20	Poss diesel generating plant				
21	Admin/engineering/lab bldg				
22	Admin bldg				
23	Vehicle shed				
24	Shipping & receiving bldg				
25	Shipping & receiving bldg				
26	Steamplant				
27	Receiving/shipping bldg				
28	Prob water treatment bldg				

[a] All lengths and widths are overall measurements; all heights are to the highest part of the structure. Test stand heights are of the superstructure only.



25X1

FIGURE 46. OMSK ROCKET ENGINE TEST FACILITY.

25X1

25X1

25X1

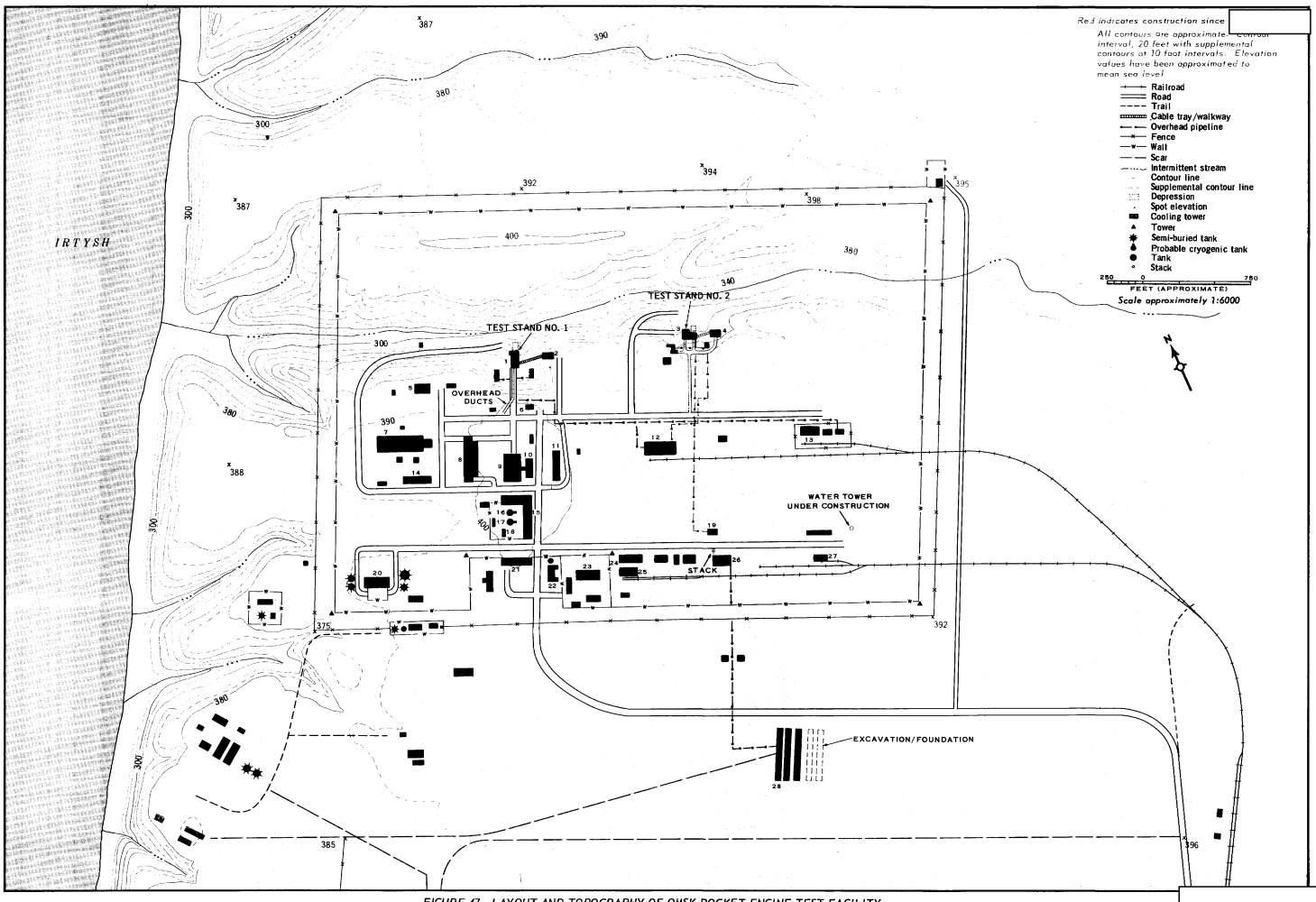


FIGURE 47. LAYOUT AND TOPOGRAPHY OF OMSK ROCKET ENGINE TEST FACILITY.

25X1

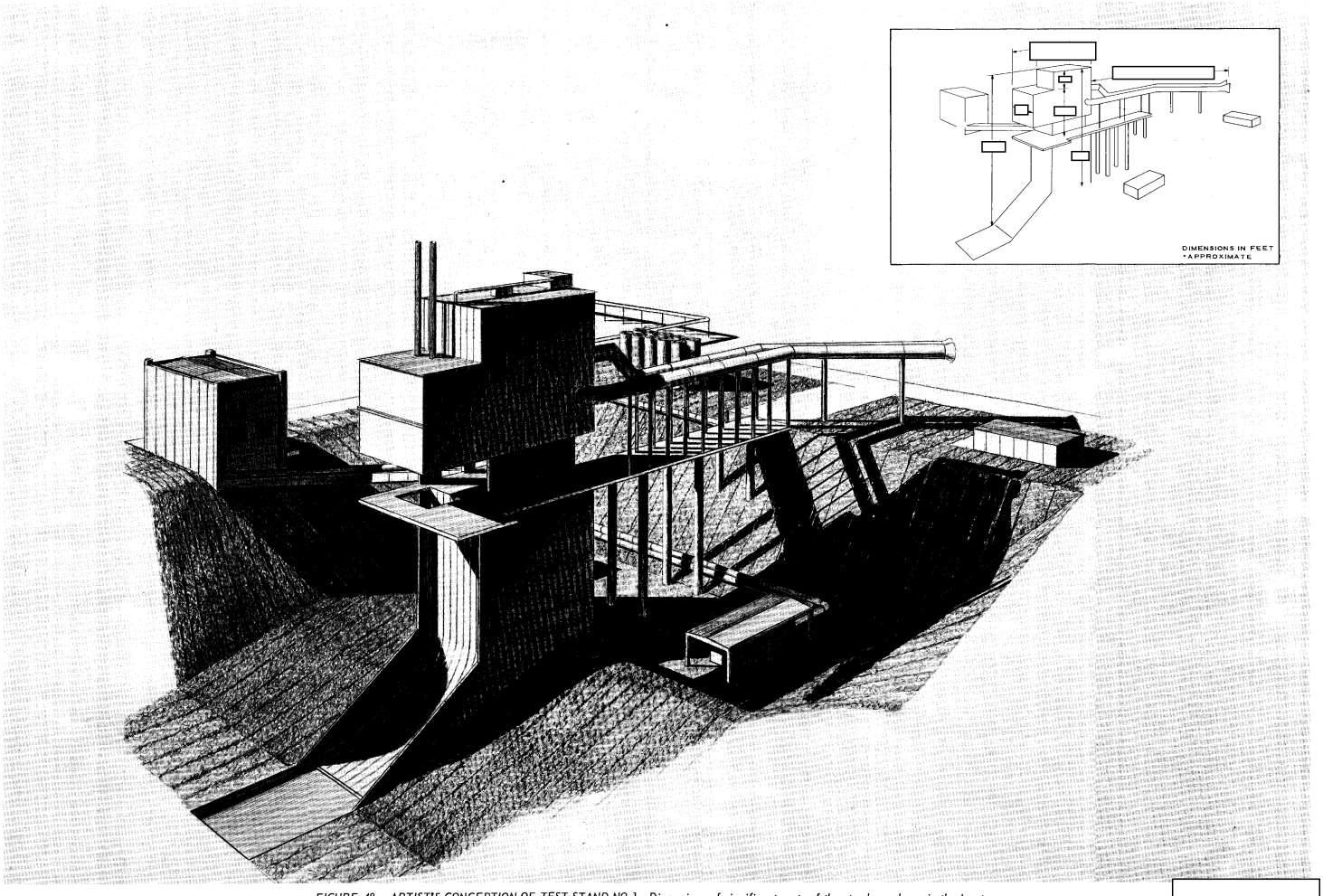


FIGURE 48. ARTIST'S CONCEPTION OF TEST STAND NO 1. Dimensions of significant parts of the stand are shown in the inset.

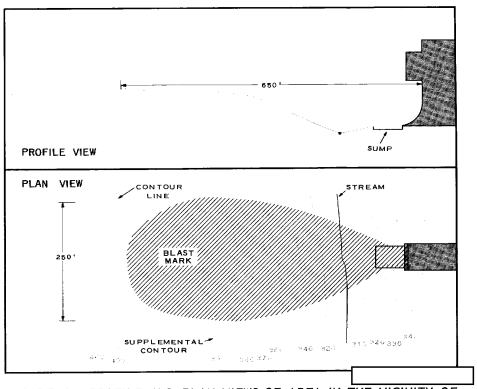
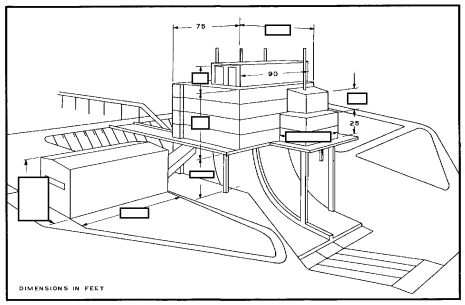


FIGURE 49. PROFILE AND PLAN VIEWS OF AREA IN THE VICINITY OF TEST STAND NO 1. These views show the extent of blast marks.

the stand was approaching completion.

Test Stand No 2 is situated approximately 1,100 feet southeast of Test Stand No 1. It is an unusual structure, apparently having 2 dissimilar firing bays or positions. An artist's conception of this stand and dimensions of it are presented in Figure 50. The superstructure rises feet above the level of the 2 access ramps which enter the rear of the stand. The superstructure measures partially overhanging projection. The entire structure rises above grade. A control and instrumentation building (item 4, Figure 47) is situated approximately 100 feet east of the stand and is connected to the stand by a cable tray/walkway.



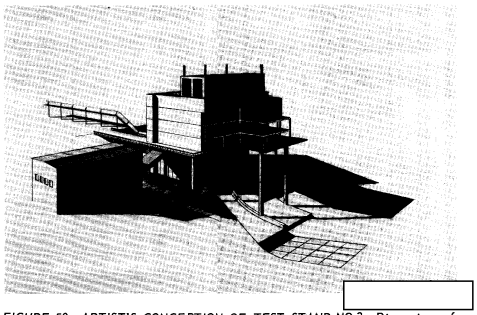
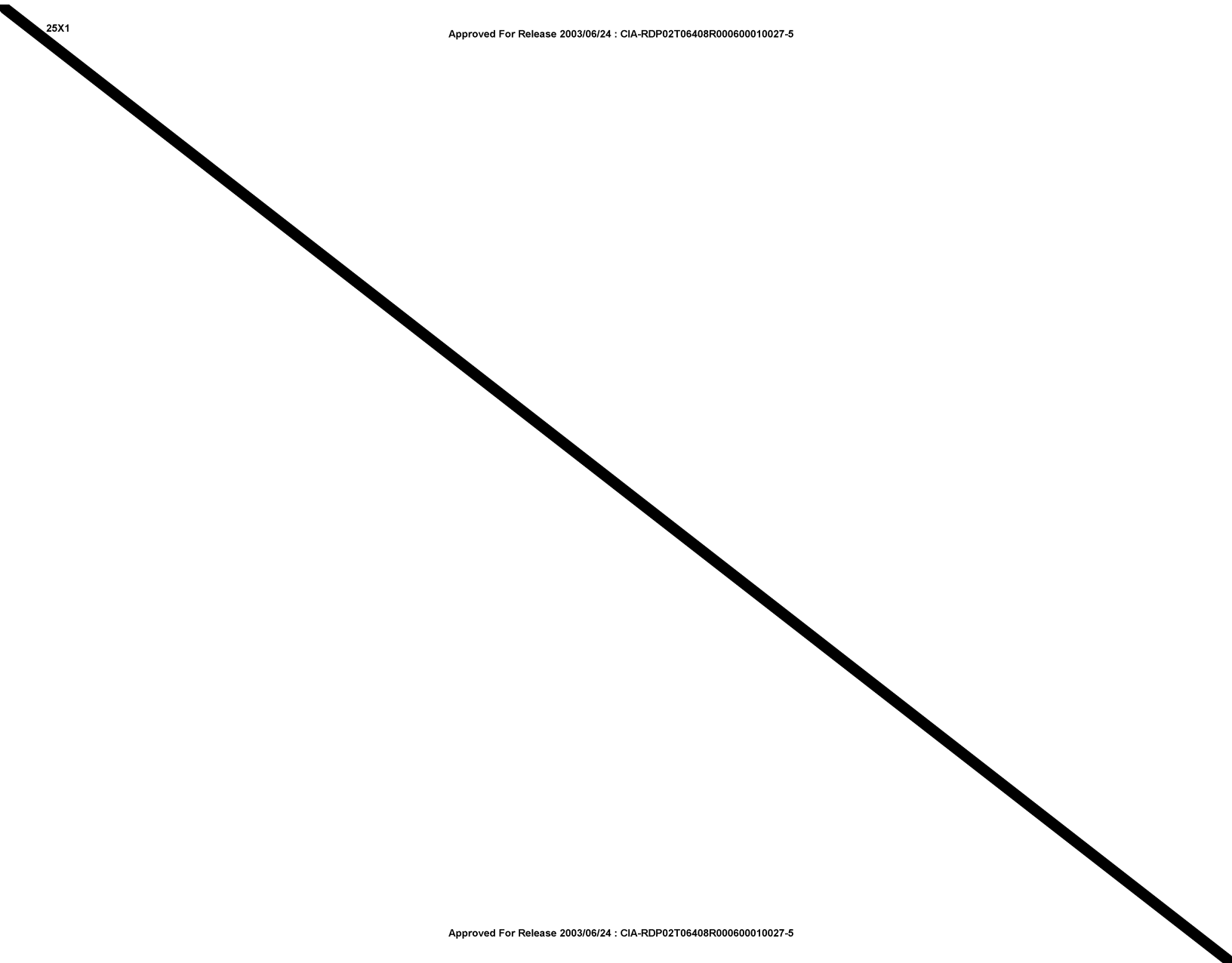


FIGURE 50. ARTIST'S CONCEPTION OF TEST STAND NO 2. Dimensions of significant parts of the stand are also shown.



COMPARISON OF SIMILAR TEST STANDS AND OTHER STRUCTURES AT SOVIET ROCKET ENGINE TEST FACILITIES PROBABLY MAINLY CONCERNED WITH PRODUCTION-TYPE TESTING

An inspection of the large vertical test stands at test facilities near Kurumoch, Krasnoyarsk, Perm, Voronezh, and Omsk reveals a number of similarities in both configuration and construction chronology.

Although Stand No 1 at the Kurumoch facility and the No 1 stands at the Krasnoyarsk and Perm facilities were under construction when first observed, an analysis of their construction status indicates that the construction of these 3 stands was begun about the same time, probably in the late 1950s. There is some justification for assuming that the facility near Kurumoch was started and completed first because the first blast mark observed from a test firing was seen at the Kurumoch Test Stand No 1 on photography of [redacted] All of these test stands were outwardly complete by at least late 1963. The variation in observed firing dates (as indicated by blast marks) at these stands, which range from [redacted] may be a result of the topography of the terrain in front of the stand; dark blast mark stains covering large areas of the adjacent slopes have not been seen at the Krasnoyarsk test facility and only an area of suspect blast scarring has been observed at the Perm test facility, even though the dark stains in the blast pits do indicate that these stands are active. The No 1 test stands at the Kurumoch, Krasnoyarsk, and Perm facilities are remarkably alike. The main structure of each stand measures 85 by 70 feet, and the partial width overhanging projections of these stands are quite similar. Minor differences are apparent in the small protrusions on top of the stands.

The excavations for Test Stand No 2 at the Kurumoch facility and the No 1 stands at the Voronezh and Omsk facilities were probably underway in mid-1961. Actual construction of the substructure of these stands dates from about late 1961 to mid-1962. All of these stands were completed by mid-1964, indicating a somewhat shorter time period of construction for these stands than that required for the older stands. The blast marks at these stands have all been characterized by large dark stains covering a considerable area. Table 10 presents the construction and operational chronology of the large vertical test stands as seen on aerial photography of varying degrees of interpretability.

Smaller test stands are also present at the Soviet test facilities. These are generally of various configurations; however, 2 of the stands at the Kurumoch facility are almost identical, and the smaller stands at the Perm and Voronezh facilities appear identical, even though the large stands at these facilities are different. Except for the 3 stands at the Kurumoch facility, all of these smaller stands appeared subsequent to the large stands. Table 11 presents the construction and operational chronology of the smaller test stands.

A comparison of the large vertical test stands at test facilities near Kurumoch, Perm, Krasnoyarsk, Voronezh, and Omsk is presented in Figures 51 and 52. A drawing of the basic designs derived from mean dimensions of each of the 2 types of test stands is also shown. It is considered possible that these dimensions may coincide with the true dimensions of 2 basic Soviet test stand designs.

Identical structures are not readily apparent at the test facilities near Khimki, Dnepropetrovsk, and Zagorsk, but better quality photography and more detailed analysis may reveal some that are identical in appearance or have identical functions. It was observed that a number of identical or very similar structures probably having similar functions appeared at the test facilities near Kurumoch, Krasnoyarsk, Perm, and Voronezh. Table 12 is a partial listing of these structures. A statistical study of a very detailed analysis of the presence or absence, location, functions, and construction dates of identical structures at these test facilities could yield valuable information concerning the various Soviet test programs.

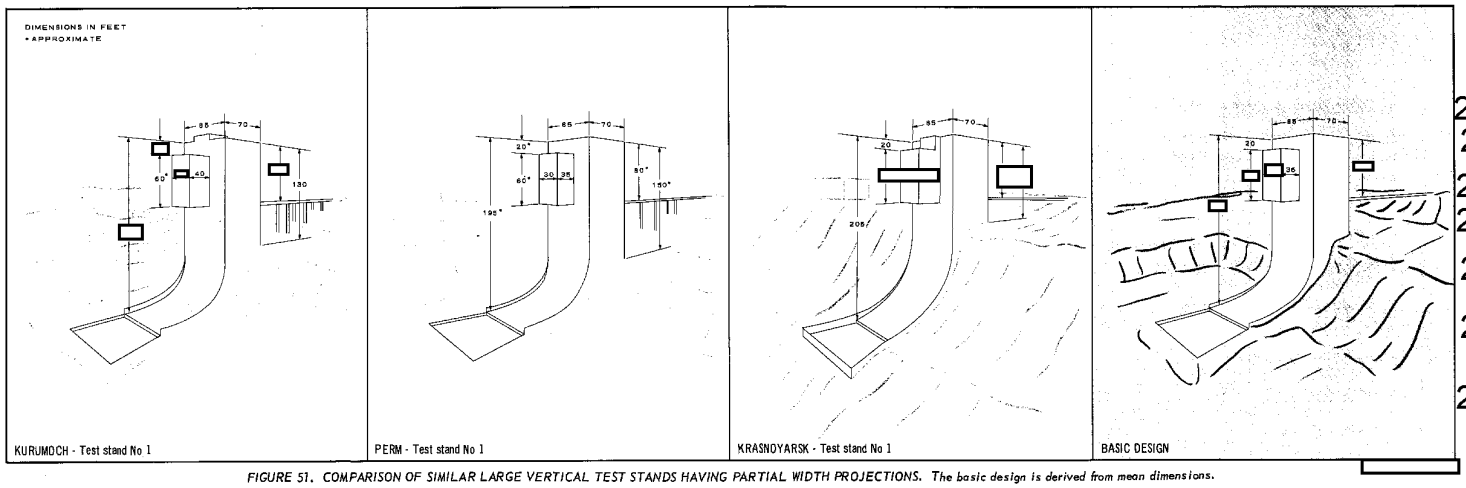


FIGURE 51. COMPARISON OF SIMILAR LARGE VERTICAL TEST STANDS HAVING PARTIAL WIDTH PROJECTIONS. The basic design is derived from mean dimensions.

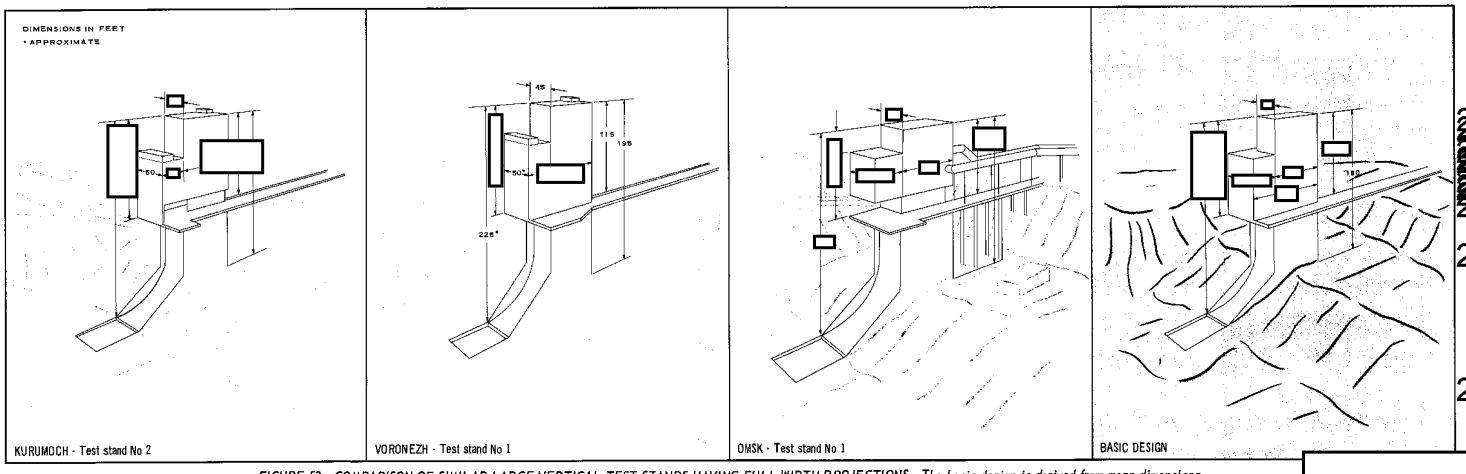


FIGURE 52. COMPARISON OF SIMILAR LARGE VERTICAL TEST STANDS HAVING FULL WIDTH PROJECTIONS. The basic design is derived from mean dimensions.

Table 10. Construction and Operational Chronology of Large Vertical Test Stands at Soviet Rocket Engine Test Facilities

Test Facility	Test Stand No	Negation Date	First Observed U/C	Construction Probably Incomplete	Construction Outwardly Complete	Last Observed No Firing Evident	First Observed Firing
Krasnoyarsk	1[a]						
Perm	1[a]						
Kurumoch	1[a]						
Kurumoch	2[aaa]						
Voronezh	1[aaa]						
Omsk	1[aaa]						

[a]Stand having a partial-width projection, constructed between late 1950s and late 1963.
[aa]Evidence of a test firing indicated by dark stains in the blast pit.
[aaa]Stand having a full-width projection, constructed between mid-1961 and mid-1964.

Table 11. Construction and Operational Chronology of Small Test Stands at Selected Soviet Rocket Engine Test Facilities

Test Facility	Test Stand No	Negation Date	First Observed U/C	Construction Probably Incomplete	Construction Outwardly Complete	Last Observed No Firing Evident	First Observed Firing
Kurumoch	3						
	4[a]						
	5[a]						
Krasnoyarsk	2						
Perm	2[aa]						
Voronezh	2[aa]						
Omsk	2						

[a]Similar vertical test stands.
[aa]Similar horizontal test stands.

Table 12. Cross-index of Similar Structures at Soviet Rocket Engine Test Facilities[a]

Description/Function of Structures	Item Numbers Appearing on Relevant Figures: Kurumoch (Fig 20)	Krasnoyarsk (Fig 29)	Perm (Fig 35)	Voronezh (Fig 41)	Omsk (Fig 47)
Vertical test stand (with partial-width projection)	27	9	24		
Vertical test stand (with full-width projection)	1			22	1
Horizontal test stand (with single diffuser)			25	20	
Assembly/checkout bldg (wide)	23, 6	5	22	24[aa]	9
Assembly/checkout bldg (narrow-200 ft long)	5			24[aa]	
Assembly/checkout bldg (narrow-125 ft long)	22	4	21		10
Control bldg (square)	26		23		
Control bldg (rectangular)	2		26	21	2
Air liquefaction plant			16		15
Air liquefaction plant (with longitudinal low section)	7, 17				
Air liquefaction plant (with unusual tanks adjacent)		10		15	
Prob cryogenic storage tanks	8-10, 19-21	11, 12	17, 18	16-18	16, 17
Cooling tower	11, 18		15	19	18
Cooling rack		15			
Poss components assembly/test bldg	24				11
Poss fuels processing/fabrication bldg		21			7
Poss pump/compressor bldg	12				8
Steamplant	15	19			
Admin bldg	34	20			22
Prob shop/fabrication bldg	13		8		14
Poss vertical tanks/pumphouse	25				6
Shipping & receiving bldg	33		7		24
Poss receiving bldg	35		9		
Rail-served receiving bldg	36		13		
Poss storage bldg, rail served	16	18, 22		14	
Small support bldg	37		14		

[a]This is a partial listing; these structures are probably mainly concerned with production-type testing.
[aa]Buildings joined to form one building.

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